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SCIENTIFIC RESEARCH AND EXPOSITION

EFFECTIVE exposition of a scientific theme is highly important at the present day, and two recently published books* provide good examples of it. Herr Jungk's book has the narrower scope, in that he limits his survey to the American scene and describes some of the projects and achievements of American scientists in the exploration of space, the development of atomic energy, in agriculture and horticulture, the control of weather, in animal biology, industrial psychology, the electronic computer and the like. By and large, he is concerned rather to depict the actual impact of such projects and achievements on the social order, and to suggest their probable effect on the society of to-morrow. In particular, he gives a graphic picture of the changes which the atomic energy programme has already wrought in Colorado, at Los Alamos, in Nevada and elsewhere. His book is a series of snapshots of a world in which man has already changed his environment and himself, rather than of the discoveries by which man has gained such control over Nature.

Mr. Kaempffert (see also p. 1211) touches on the exploration of space, the ionosphere, weather control, supersonic flight, atomic energy, the possibilities of generating energy from the sun, advances in animal and human biology and their implication for the control or prevention of diseases like cancer, but he gives a highly skilled and readily intelligible exposition of the scientific discoveries concerned, the way they have been made and something of what they mean for mankind. Further, Mr. Kaempffert's book is not restricted to the American scene. Moreover, its clear pictures of the nature of the process of scientific discovery and the working of the scientific mind depict the scientist as a human being, whereas Herr Jungk's picture of the scientist is that of a mystery man, even one who is carrying the conquest of Nature so far as to attempt to make himself into a god. In an address to the American Association for the Advancement of Science at Philadelphia in December 1951, Prof. Kirtley Mather discussed such anti-scientific tendencies and their significance. While such trends have undoubtedly caused scientists themselves to consider more carefully the social consequences of their work, it has not been made any easier thereby for science to make its full contribution to human welfare and the practical affairs of everyday life. Indeed, as much of the discussion over the hydrogen bomb indicates, muddled thinking and a confusion of moral issues with practical affairs lead to evasion of the hard intellectual effort required to evolve adequate means of international control and co-operation, which are the real challenge of the situation.

* Tomorrow is Already Here: Scenes from a Man-Made World. By Robert Jungk. (Translated from the German by Marguerite Waldman.) Pp. 239+15 plates. (London: Rupert Hart-Davis, Ltd., 1954.) 16*s.* net.

Explorations in Science. By Waldemar Kaempffert. Pp. 288. (London: Victor Gollancz, Ltd., 1953.) 12*s.* 6*d.* net.

Both books, it is true, demonstrate the inescapable contact between science and politics; but whereas Herr Jungk gives no indication as to how that contact should be guided, Mr. Kaempffert shows that there is a certain amount of common ground, and that it is possible for the scientist and politician to walk together on terms of mutual respect and understanding. That is to say, Mr. Kaempffert has not stopped at exposition: he has carried his venture in communication to the point of interpretation, so that the ordinary citizen, whether politician or scientist working at some other frontier of knowledge, farmer, salesman, housewife, airman or soldier, can gain some understanding of what the scientist is doing, how he goes about his work, its implications for the world of to-day and the conditions essential for the continuance of such scientific work. In the main, this is done in the concluding three chapters of the book, in which Mr. Kaempffert explains the nature of the scientific method and its requirements, and how it is that the application of scientific discovery inevitably involves social change, paying at the same time a deserved tribute to Wells's efforts in this direction. Nevertheless, the same theme is implicit and often explicit in his accounts of particular developments in the earlier part of the book.

This interdependence of science and politics was brought out even more effectively by Prof. Kirtley Mather in his retiring presidential address to the American Association for the Advancement of Science in December 1952. That interdependence, he urged, especially the increasing dependence of fundamental science upon public funds, has made it imperative to make the common ground of science and politics more obvious, to encourage the co-operation of scientists and politicians in the service of mankind, and to eliminate recrimination and distrust. Prof. Mather referred then to the marked reluctance of scientists in the United States to enter Federal Government service, and foretold the further damage to relations between scientists and the Federal Government done by the passage of the McCarran Act by Congress over the President's veto.

On this point of the conflict between intellectual freedom, essential to scientific progress, and national security, and the contribution of the individual or minority to creative thought, Prof. Mather expounded the real issues no less vividly than Prof. A. Macbeath did in his 'plea for heretics' before the British Association at Belfast. Nor did he hesitate to insist that the ideas of competent scientists should play an effective part in determining the limits of security measures. He recognized that the removal of the present stultifying atmosphere and the acceptance of reasonable standards for scientific freedom demand a public understanding which can only come with education and the establishment of effective means of communication—interpretation as well as exposition.

That is a task of integration in which both scientists and politicians have a place. The scientist must assist in developing a climate of opinion that recognizes the supreme worth of intellectual freedom. He must resist vigorously any tendencies in education or elsewhere that pervert democratic institutions into means for the expression of group prejudice and autocracy inimical alike to science and the general well-being.

Referring again to the books by Dr. Jungk and Mr. Kaempffert, it must be pointed out that both authors bring out very clearly the conditions of scientific advance and the grave danger to science in the United States and elsewhere arising from the real or imagined need for secrecy and its effect on the free exchange of information and ideas. Both Jungk and Kaempffert put this issue of freedom of communication, debate and discussion in its proper perspective in relation to scientific advance; and the consequences of failing to hold a reasonable balance in practice between the claims of 'security' and the exploration upon which real continuing security depends are clearly shown.

But this is only one illustration of the importance of clear interpretation of the possibilities in presenting science to the public. Interpretation is one of the most important functions in the presentation of science and the scientist has the duty at least to assist in that interpretation. But it may not succeed until the non-scientist realizes that science is not necessarily linked up with atom bombs and destruction. Neglect to carry out that task may well involve restraints on scientific work which may gravely hinder its prosecution. It may result in disastrous direction from outside or the withholding of essential funds, now increasingly drawn from public sources.

Scientific advance itself, no less than the effective application of science in industrial and national affairs, depends increasingly on the extent to which not merely the government, but also the ordinary citizens on whose support government ultimately depends in a democracy, should have some understanding of what is happening in science, an appreciation of how it can be wisely utilized and a sense of responsibility for its prosecution. That is one of the primary reasons for the concern of the scientist with the problem of education as a whole; the effectiveness of the educational system determines largely the means he must adopt to deal with his problem of communication as well as the efficiency of those means. Also, as corollary, it requires him to examine closely his objectives in this task of communication and the appropriateness of the means at his disposal.

The importance of this latter factor was well illustrated by the Reith Lectures given last year by Prof. J. R. Oppenheimer. The Reith Lectures are above all an attempt to communicate not so much information as ideas to a widespread serious and attentive audience. Their success in achieving their declared purpose is to be judged by the extent to which they stimulate thought and promote public understanding of some great issues of the day, or in other words, just that understanding and sense of responsibility upon which we have frequently insisted in respect of science.

Nevertheless, the criteria of success are not mass criteria. It is true that the Reith lecturer, like other expositors and interpreters, requires

some understanding of the outlook, the sympathies and the limitations of the ordinary folk who make up the millions of his listeners; he is equally entitled to expect of his listeners a more serious intellectual effort than would be expected of the viewer at a cinema or the ordinary television programme. Exposition and interpretation are more than entertainment. They involve co-operation, but that co-operation will only be secured if interest is aroused. The comparative failure of Prof. Oppenheimer's lectures to make any effective impact on so many of his listeners was, however, not due so much to the scientific limitations of his audience as to failure to present his theme in a setting which, by challenging and capturing the interest of his listeners, would induce them to make just the necessary effort for them to apprehend, even without a scientific or mathematical training, something of the bearing of scientific thought, and nuclear physics in particular, on the society of to-day. That it can be done Oppenheimer himself has shown, for example, in an earlier article on the encouragement of science, in which he expounded a letter of Jefferson on the relations between science and political life in a way that no hearer of the Reith Lectures could have failed to apprehend. Nor need erudition exclude either creative thought or the stimulation of healthy argument.

The Reith Lectures are not, of course, limited to the presentation of a scientific world picture, and it has to be admitted that those given by scientists have not been among the most successful. An even more serious defect, however, in another series has been the failure of the lecturer to take account of the limitations of such a vast audience, so that the picture of world history which he presented became dangerously tendentious where members of his audience did not possess the knowledge to correct the effect of deliberate or accidental omissions. None the less, such lecturers as Lord Russell, Mr. Robert Birley and Lord Radcliffe have achieved such success in stimulating thought and presenting vital issues that the possibilities of this method of communication should be fully explored and utilized, and there is every reason for believing that Sir Oliver Frank's forthcoming lectures on "Britain and the Tide of World Affairs" will touch as high a level as any of the earlier lectures.

At a time when, however, the educational and formative influence of such a new mass media as television is still a matter of discussion and experiment, and when the scarcity of science teachers in the schools threatens both the supply of scientists and the education in science of the general citizen, and especially of the leaders in all walks of life, it is well to remember that the effectiveness of the exposition of science is not set solely by the skilfulness of the expositor in presentation or interpretation. His choice of means is limited in part by the general level of education and understanding of the community in general. These are the factors which determine the amount of co-operation on which he can depend in arousing and maintaining interest. When all stress has been laid on the need for scientists as such to address themselves much more carefully to this question of communication and presentation, to co-operate fully with those who take up this task, whether they be scientists themselves or journalists, and whether the media be the spoken, the written, or the broadcast word, or the newer visual media, it still remains true that it is in the schools that the foundations of the understanding of science must be laid. Unless the beginning made there is sound, no efforts of scientists or others in the presentation of science are likely to convey to the ordinary citizen the real understanding which he needs, of what science is, and how it can contribute to the welfare of man or, if misused, to the undoing of mankind.

THE DISPLACED SCHOLARS AND SCIENTISTS OF 1933–52

The Rescue and Achievement of Refugee Scholars

The Story of Displaced Scholars and Scientists 1933–1952. By Norman Bentwich. (Studies in Social Life—1.) Pp. xiv+108. (The Hague: Martinus Nijhoff, N.V., 1953.) 6.25 guilders.

THE story which Prof. Norman Bentwich has to tell of the refugee scholars who were displaced from the Dictator-States between the years 1933 and 1952 is brim-full of human interest. When in the former year Hitler came into power as Chancellor of the German Reich, he took advantage of the unfortunate circumstance that the universities and research institutes were in general State-owned and their staffs State officials, so that it was an easy matter to 'cleanse' such establishments by ordering that all those considered to be of other than 'Aryan' origin, or not whole-hearted Nazis, should be summarily dismissed. This led to the elimination of more than twelve hundred scholars and scientists within the next two years. Inside Germany itself, there was but little resistance to this drastic policy, and the few who objected were themselves removed. Nor was there within Germany itself any organized movement to help those thrown out; any help that did come had to be from outside.

It is in this way that the author introduces his subject, and all that happened in those critical years had a deep influence on what was to follow when the countries of eastern Europe came more and more under German control. That the institutions concerned were attached so intimately to the State would, no doubt, not have been so serious a handicap in the days when there existed many small dukedoms and principalities to which a rejected scholar could turn; but it became devastating when an all-embracing central government was in such complete control that even rectorial heads had to model themselves to behave as little 'Führers'. In fact, as was graphically said in an article in the *Universities Review* of April 1936, by Prof. A. V. Hill, Sir F. Gowland Hopkins and Sir Frederic Kenyon: "A German university under the new regime is as to the one part a regiment preparing for war, as to the other an intellectual concentration camp".

Efforts directed towards the rescue of scholarship were made in increasing degree by Western States, largely on the initiative of Great Britain, which set up, under the presidency of Lord Rutherford, an

Academic Assistance Council (succeeded a few years later by the larger "Society for the Protection of Science and Learning", which is still functioning). In 1935 the U.S.S.R. itself became one of the many States in which displaced scholars could find temporary shelter; but that did not long endure, and by 1936 there followed the forced return of almost all of them and even the imprisonment of some. By this time the number displaced from the German universities had risen to seventeen hundred, and their conditions of life became steadily worse. (Although China in its turn became another source of academic exiles, this chiefly concerned the student body and is therefore not included in Prof. Bentwich's survey; it was looked after by the International Student Service with a centre in Geneva.)

The Nazi attack on scholars in Austria and Italy in 1938 led to the displacement of a further five hundred university teachers and scholars. Here again, willing help was given by Britain to the victims; but with the outbreak of the Second World War it was realized that private aid could not carry so heavy a burden by itself and that the British Government must needs shoulder a large portion of it. As the war area spread, other Western European countries suffered in much the same way, and if the means of escape became harder the ingenuity employed became greater: the famous scientist, Niels Bohr, had to get away in a fishing boat at night.

By 1945 the total number of academic refugees registered by the Society for the Protection of Science and Learning rose to more than twenty-five hundred; of those, about half were from Germany and the rest from other European countries. In Britain and the United States the number each received was more than six hundred, most of whom have since become part of the scholarly groups in those two countries.

When Hitler began this cruel and foolish attack on German scientists, he is reported to have said: "If the dismissal of Jewish scientists means the annihilation of contemporary German science, we shall do without science for a few years". Seven years later Sir Winston Churchill thus assessed the fatal consequence: "Since the Germans drove the Jews out of Germany . . . our science is definitely ahead of theirs"; this is graphically epitomized by Prof. Bentwich as "the Nemesis which attended the National Hubris of the Nazis".

In an eloquent epilogue, Prof. A. V. Hill sums up the story of those hard days: the Academic Assistance Council, he says, had no partisan, political or national bias, and indiscriminate relief was no part of its work. "Its purpose was to act as a link between the scientific workers and other scholars displaced and the universities and research institutions of the world, so that their exceptional abilities exceptionally trained—to quote the noble declaration of the Council's founders—should not be lost". Those who took part in it may well be moved with pride—and humility—when reminded by some friend of the many perils in which scholarship then stood and how the danger had been alleviated by the sympathy and generosity of fellow workers in the West.

Prof. Bentwich aims also at the inclusion of some account of the subsequent achievements of the refugee scholars; but it may be questioned whether this is really necessary. The qualities of the men and the response they naturally made to the opportunities of work opened so gladly to them tell unaided their own story.

H. E. Wimperis

MALAYAN ORCHIDS

A Revised Flora of Malaya

An Illustrated Systematic Account of the Malayan Flora, Including Commonly Cultivated Plants. Vol. 1: Orchids of Malaya. By Prof. R. E. Holttum. Pp. v+753+4 plates. (Singapore: Government Printing Office, 1953.) 20 Malayan dollars.

THE continuous advance in our knowledge of the floras of the world renders necessary the appearance at intervals of summations of that knowledge, either in the form of monographic studies of natural groups of plants, or of Floras of various geographical regions. One region in which a new presentation of our knowledge is required is Malaya, since Ridley's "Flora of the Malay Peninsula" was published about thirty years ago and, moreover, was to a considerable extent based on insufficient data.

The appearance of the first volume of a new Flora of this region is therefore to be welcomed, and it is a happy choice that this volume should deal with the Orchidaceae, a family of outstanding interest both to the scientific botanist and to the plant lover. Prof. R. E. Holttum has long been interested in these plants; but it was only during the war-time occupation of Singapore by the Japanese that he perforce had the leisure in which to carry out the work necessary for the preparation of the present book.

Apart from botanical exploration in Malaya itself since the publication of Ridley's Flora and the incorporation of the results into a new Flora, it has been essential to consider the Malayan orchids in the light of the extensive researches carried out by the late Dr. J. J. Smith on the orchids of the Malaysian region in general. Smith's work is of fundamental importance in the study of the orchids of this region, and the application of the results of his researches to the Malayan orchids has necessitated many changes from the names and classification in Ridley's account.

Most Floras include, in addition to the native species, a selection of the more important established aliens, but Prof. Holttum breaks new ground by including accounts of the genera, species and hybrids more generally cultivated in Malaya. This renders the book of interest to orchid growers as well and permits of a wider treatment of genera and subgeneric groups. This is advantageous when the cultivated plants are of Malaysian origin, since the native orchids of Malaya are a rather scrappy selection of the total Indo-Malaysian orchid flora. The inclusion of American and African groups and genera is less satisfactory. It is impossible in the space available to deal with these groups adequately, though it must be confessed that the author has provided much useful information. The writer is somewhat sceptical, however, of the possibility of naming with certainty many of these exotic orchids from the data provided; moreover, the introduction of new species and the continuous production of new hybrids will fairly soon render this part of the account out of date.

The numerous keys to the genera, parts of genera, and species form one of the very useful features of the book. These are of particular importance in the large genera, like *Dendrobium*, *Bulbophyllum* and *Eria*, as some of these sectional groups have never been distinguished in this clear manner before. Prof. Holttum takes, on the whole, a rather conservative attitude towards genera, but gives full weight to modern work on the Malaysian monopodial orchids,

in which several of the cumbersome genera have been divided into more natural groups. An excellent key to the genera of this group is provided, based mainly on J. J. Smith's work.

The book is illustrated by four attractive colour-plates of hybrids and more than 230 line-drawings, mostly from the pen of the author. These are especially valuable in showing the diagnostic features of the species and genera figured, besides supplementing the very clear descriptions. For the orchid grower in the tropics there are introductory chapters on the cultivation both of adult plants and of seedlings and, for orchid growers in general, excellent accounts of the main hybrid groups which have been developed in tropical countries. These include *Spathoglottis*, *Dendrobium* and the numerous bigeneric hybrids belonging to the large monopodial group. The latest results are here brought together by one who has been closely associated with much of this hybridization in recent years.

Altogether Prof. Holttum's book provides a very satisfying account of the orchids of Malaya, and will no doubt for long be the standard reference book on this subject. V. S. SUMMERHAYES

THE ROTHSCHILD COLLECTION OF FLEAS

An Illustrated Catalogue of the Rothschild Collection of Fleas (Siphonaptera) in the British Museum (Natural History), with Keys and Short Descriptions for the Identification of Families, Genera, Species and Subspecies. By G. H. E. Hopkins and Miriam Rothschild. Vol. 1: Tungidae and Pulicidæ. Pp. xv+361+45 plates. (London: British Museum (Natural History), 1953.) 84*s*.

ALTHOUGH one of the 'smaller orders' of insects (about 1,350 described species and sub-species), the Siphonaptera, or fleas, are the subject of a considerable volume of taxonomic literature, mostly written during the past half-century, or since the role of some species as vectors of bubonic plague was proved. A world list published in 1895 included only thirty-five species. About that time, three entomologists, Julius Wagner in Russia, Carl F. Baker in the United States, and the Hon. N. Charles Rothschild in England, turned their attentions to this virtually neglected group of small and despised insects. All three left their mark in flea taxonomy; but it was Rothschild who amassed what is even to-day the world's most representative collection. Working at first alone but later with his friend and colleague Karl Jordan, Rothschild published numerous descriptions of genera and species that set a standard of definition and accuracy not often excelled to-day. At an early stage Rothschild realized the importance of the collection he was building, and by deed of gift in 1913 arranged that it become the property of the British Museum (Natural History) on his death. According to one of the provisions of the deed, the trustees were to "cause to be made and published a catalogue giving the names and full number of specimens of each species of parasitic insect in the said collection".

The collection became the property of the Museum in 1923, on Rothschild's death; but thirty years were to elapse before the catalogue could be prepared. The delay has been advantageous in many ways: the collection has continued to grow; numerous new species, genera and other categories have been described; and most important, Karl Jordan, the greatest authority on the order, has had time to study the difficult problems of phylogeny, which had to be considered before a natural classification could be proposed, a task that would have been impractical three decades ago.

The book under review, then, is the first volume (of five) of the promised catalogue, and is the work of G. H. E. Hopkins and the Hon. Miriam Rothschild (daughter of Charles). The authors set themselves three objectives: to fulfil the terms of the deed of gift; to provide keys, descriptive notes and figures to aid in the identification of all known species; and to publish the skeleton classification made by Dr. Jordan. Despite their modest assertions to the contrary, this work will virtually constitute a monograph of the Siphonaptera of the world.

A preface and foreword are followed by an introduction, which defines the scope of the catalogue and gives some particulars about the collection, which now contains about eleven hundred, or more than 80 per cent, of the known species and sub-species, including 682 holotypes and lectotypes of valid forms, as well as numerous paratypes, and types of synonyms.

Of great interest are the provisional phylogenetic tree illustrating Jordan's views on the broad relationships of the seventeen families of fleas, and a table of the valid genera and subgenera, which number about two hundred, with their families and subfamilies. An illustrated and annotated glossary, covering twenty pages, will prove most useful, as there has been much non-conformity in interpretation and terminology of flea anatomy; the usage in the present catalogue is therefore defined. This section is followed by keys and the main body of the text.

The authors follow Jordan (1948, in Smart) in considering the Siphonaptera as divisible into two superfamilies, the Pulicoidea (the smaller, and the topic of Vol. 1) and the Ceratophylloidea. The Pulicoidea contain two families, the Tungidae (subfamilies Tunginae and Hectopsyllinae) and the Pulicidae (Pulicinae, Archaeopsyllinae, Spilopsyllinae and Xenopsyllinae). In all, 24 genera and 147 species and sub-species are considered to belong to the Pulicoidea. Adequate keys (tested by the reviewer on specimens of about sixty species) and concise descriptions are provided for all categories. The important but difficult genus *Xenopsylla* (fifty-seven species) is broken down into eight species-groups. Locality and host records are limited to material in the collection and examined by the authors. These are arranged geographically according to the regions and sub-regions defined in Bartholomew, Eagle Clarke and Grimshaw's "Atlas of Zoogeography" (1911), an arrangement that is satisfactory for the purposes of the catalogue. Host nomenclature has been revised to conform with the recent works of Ellerman, Peters and others. There is little or no discussion of host relationships or geographical distribution *per se*.

The book is profusely illustrated by line-drawings of the diagnostic structures of the species. There is some lack of uniformity in the figures in that they were prepared by a number of individuals; but they have been well selected and a high standard of quality has been maintained. Forty-five plates of

truly excellent photographs of fleas deserve special mention. These are mostly the work of Arthur Barron and are quite the best and most useful photographs of fleas I have seen. It is to be hoped that the succeeding volumes will be similarly illustrated.

It is understood that Vol. 2, covering seven families (Coptopsyllidae, Vermipsyllidae, Stephanocircidae, Hypsophthalmidae, Ischnopsyllidae, Macropsyllidae and Xiphiopsyllidae) of the Ceratophylloidea is due for publication. The appearance of this and succeeding volumes will be eagerly awaited by all students of fleas. Meanwhile, the authors and publisher may be congratulated on the high quality and practical usefulness of the first volume of a work that will be the standard reference on fleas for many years to come.

G. P. Holland

MATHEMATICAL METHODS

Methods of Theoretical Physics

By Prof. Philip M. Morse and Prof. Herman Feshbach. (International Series in Pure and Applied Physics.) Part 1: Chapters 1 to 8. Pp. xxii+998+xl. Part 2: Chapters 9 to 13. Pp. xviii+999–1978. (London: McGraw-Hill Publishing Company, Ltd., 1953.) 120s. each volume.

THEORETICAL physics to-day has a vast content. To expound fully the mathematical methods which are necessary for the development of the major branches of the subject would be a great undertaking. Authors of text-books on the methods of theoretical physics must therefore choose between covering a very wide variety of methods in a superficial kind of way, and treating a restricted range of topics comprehensively. It is this latter course which Profs. Morse and Feshbach adopt. Despite its general title and its great length, their work consists almost entirely of an exposition of the methods of solving Laplace's equation, Schrödinger's equation, and the scalar wave equation. It is, however, an excellent account of these topics and will doubtless become a standard work.

The first three chapters of Part 1 consist of an account of various types of field (scalar, vector, tensor) occurring in theoretical physics, and of the differential equations and variational principles governing them. This is followed by three chapters on functions of a complex variable, ordinary differential equations and the theory of eigenfunctions, respectively. A great deal of the material in these first six chapters (covering nearly eight hundred pages) is familiar, but it is discussed in a manner particularly suited to the needs of the mathematical physicist. The treatment is always interesting, and sometimes novel—for example, the discussion of the 'Euler' transform in Chapter 5. The last two chapters of the first volume are devoted to the Green's function technique for the solution of partial differential equations, and to the theory of integral equations. The account of the method of Green's functions is particularly clear and attractive.

The second volume begins with an account of the three main approximate methods of solution of boundary value problems in physics: (1) the perturbation method, (2) the variational method, (3) the variation-iterational method. That this chapter is long (more than 170 pages), and difficult, is due largely to the fact that the authors have illustrated the methods they describe by applying them to difficult and worth-while problems of the kind which a theoretician will encounter in the course of his researches, rather than to the artificial kind of problem one encounters all too often in mathematical treatises. The remainder of the work is devoted to the application of the principles already established to the differential equations of mathematical physics —Laplace's and Poisson's equations, the wave equation, the diffusion equation, Schrödinger's equation. The partial differential equation approach (separable systems) is developed for exact solutions, the integral equation approach for approximate solutions.

From this brief description of the contents of the book it will be seen that it is, as the authors state in the preface, more a treatise on the boundary value problems of mathematical physics than a comprehensive account of mathematical methods. For example, it treats very sketchily, or omits entirely, the theory of characteristics, the flow of fluids, supersonic flow, and the equations governing the behaviour of solid continua. It does not develop either the theory of groups or the theory of matrices, both of which are of great use in theoretical physics. Nor is the use of dyadics rather than tensors a very happy choice. But within their limited field the authors have produced a work which, both on account of the amount of physics and the rigour of the mathematics, is very nearly complete and self-contained.

The striking feature of the whole work is the clarity of the exposition. Difficulties are not avoided or treated superficially. Little attempt has been made to compress the material; this may have led to a book of great length, but it has also produced one of great value. As has already been indicated, the physical problems which the authors discuss have been chosen for their current interest, and are seldom trivial. No attempt has been made to produce solutions from 'thin air'—the problems are tackled in a systematic way which not only illustrates the basic points of the theory, but also helps the young research worker to acquire a body of technique sufficient to enable him to grapple with the problems he encounters in the course of his researches. Running through the book is the view that very few problems in mathematical physics are capable of exact solution, so that the student must acquire facility in deriving approximate solutions. The approximate methods which the authors develop are analytical in nature. The fact that they do not discuss purely numerical techniques, such as 'relaxation', is not a serious drawback, since there are already in existence several admirable accounts of these methods.

The standard of book production is well up to the excellence of the authors' writing. The printing, the lay-out and the illustrations of the book are of an exceptionally high quality, and make it a pleasure to use. The book's one disadvantage is one which will not have escaped the publishers: its high price (£12 for two volumes) makes it impossible for all but a very few students to possess it. It is difficult to see how a book of this length could have been other than expensive; but it is a pity that it cannot be readily available to students. It should, of course, be in the library of every mathematical department. It will not lie undisturbed upon the shelves, for it contains a very great deal which will be of value to all who have to learn (or have to teach) mathematical physics.

I. N. Sneddon

The Yearbook of the Universities of the Commonwealth, 1954

Edited by Dr. J. F. Foster. (Thirty-first issue.) Pp. lviii+1916. (London: Association of Universities of the British Commonwealth, 1954.) 63*s*.

ONCE again the Association of Universities of the British Commonwealth has produced its "Yearbook". This year's edition is more than a hundred pages longer than the last one, but remains at the same price.

The only additional complete entry for an institution this year is the Nova Scotia Agricultural College; but mention is made of the establishment in July 1953 of a second university in East Pakistan, the University of Rajshahi, and of Rhodesia University College, Salisbury, and it is hoped to have full entries for these in next year's edition. Of the other new material, the introduction for the universities in Australia has been specially rewritten by the Secretary of the Australian Vice-Chancellor's Committee, and a fuller statement is included of the history and functions of the Association of Universities of the British Commonwealth. In addition, an attempt has been made for the first time this year to give for each university and university college in the United Kingdom a short statistical note of the numbers of its students who come from other countries.

Besides the various national sections with the staff lists for each of their university institutions, the usual host of information is to be found in the nine appendixes. The alphabetical list of names contains more than thirty thousand entries. Once again the important point must be emphasized that this book records all the university institutions of the British Commonwealth and not merely those—the majority, in fact—that are members of the Association of Universities of the British Commonwealth. Indeed, in one of the appendixes are the respective lists for the universities in the Republic of Ireland. The point is well made in the preface that, although this book is not international in the comprehensive world-wide sense, it covers such a large part of the globe and includes such a diversity of countries and races that it must surely rank as one of the leading international works of reference about universities.

Vulkanismus und andere Tiefenkräfte der Erde

Von Carl Chr. Beringer. (Kosmos Bändchen No. 200.) Pp. 64. (Stuttgart: Kosmos-Gesellschaft der Naturfreunde, 1953.) n.p.

THIS booklet is one of a series designed to make a popular appeal to various subjects in science and natural history. The title is somewhat misleading, since the first fifty-two of its sixty-four pages are devoted entirely to a condensed account of the main modern volcanic eruptions, their types and distribution. It is well illustrated with plates and diagrams, though the map of the world (frontispiece) oddly omits the British Isles. The phenomena of fissure-eruptions, plateau-basalts and pillow-lavas receive but scant attention, and the relationship of the acid or basic composition of the lavas to the types of eruption is not made clear.

The second part of the book, which attempts to deal with the other deep-seated agencies in the earth's crust in a dozen pages, not unnaturally fails. It includes a short description of bathyliths, the hypothesis of shells surrounding a nickel-iron core and a note on supposed convection currents within it; the barest mention of continental drift, radioactivity, geosynclines, orogeny and earthquakes; and expresses the belief that volcanic activity is steadily waning through the passage of geological time.

The bibliography contains a list of seventeen authors, seven of them in the nineteenth century from 1808 upwards; the only reference in English is dated 1825. Surely in 1953 a representative and up-to-date conspectus of the principal literature could have been included?

The booklet is well printed in Roman characters, on paper which seems equally suitable for text and plates. It would serve its purpose far better were the title restricted to vulcanology with more generous treatment, while discarding the unsatisfactory tailpiece. This could well be developed into a companion volume on geophysics and dynamics.

D. W. BISHOPP

From an Antique Land

Ancient and Modern in the Middle East. By Dr. Julian Huxley. Pp. 310+49 plates. (London: Max Parrish and Co., Ltd., 1954.) 25*s*. net.

THIS is a delightful book and as a record of travel in the post-war Middle East is outstanding in its merits. The author, travelling on the affairs of Unesco, visited and recorded his impressions of nearly every place of importance which is readily accessible. Even places with which a reader is perhaps very familiar assume a new interest when viewed through the author's inquiring eyes; and almost equally so when seen through the lens of his camera. The photographic illustrations, many of them in colour, are superb, and we can only regret that there are not more of them.

In his introduction, the author modestly claims that even after his wide and hurried travels and his study of the works of authorities, his knowledge remains "extremely scrappy". If this is so, his marshalling and analysis of his scrappy knowledge is most satisfactory; and his chapter on the birth of civilization is, in the writer's view, masterly. It is only when we read an essay such as this that we can fully realize the vast accumulation of historical fact that has been laid bare by the archæologist during the past half-century.

To any prospective traveller in the Middle East countries, this book should prove invaluable reading prior to his journey; and even more interesting entertainment on his return.

W. B. EMERY

Metallurgical Abstracts

(General and Non-Ferrous). Edited by N. B. Vaughan. Vol. 18, 1950–51 (New Series). Pp. viii+925. (London: Institute of Metals, 1951.)

THIS volume for 1950–51 of "Metallurgical Abstracts" maintains the high standard set by the Institute of Metals and should be invaluable to all metallurgists. The writing is in general clear and good; but more concise phrasing would result in a saving of several lines per page without any loss of subject-matter, and would avoid the necessity of unpleasing abbreviations, such as 'temp.' for temperature, which spoil the appearance of the volume. It may be suggested that, in view of the knowledge of English in so many countries, the abstracts would be of more value if a greater proportion of the space were given to the more important papers in the obscurer languages.

W. HUME-ROTHERY

CHANGES IN WORLD GLACIATION

A GEOPHYSICAL Discussion of the Royal Astronomical Society in conjunction with the British Glaciological Society was held at Burlington House, London, on January 29, the subject being "Changes in World Glaciation". The principal speakers were as follow: Prof. F. E. Zeuner (Institute of Archæology, University of London), Dr. J. D. H. Wiseman (British Museum (Natural History), London), Prof. G. Manley (Bedford College, London) and Mr. F. Hoyle (St. John's College, Cambridge), in that order. Mr. Gerald Seligman, president of the British Glaciological Society, was in the chair.

Without doubt such a subject of discussion ranks with several others of a cheerfully provocative kind in which it is not given to any one group of scientists to provide the answer. In a sense, such major issues offer not only a meeting-ground but also a much-welcomed stimulus. It has long been proverbial that he who wants to set a university by the ears with the view of encouraging the students can scarcely do better than arrange a symposium on such subjects as submarine canyons or cloud physics. In a symposium on climatic change the geologist busy with his muds lifts his eyes again to the stars; the astronomer is suddenly reminded that he must bring down his time-scale to cope with the mundane requirements of the botanist; the environmental archæologist seeks more fundamental reasons for the pathetic squalor of his kitchen-middens. The physicist is led to reconsider the yielding of masses of ice under varying conditions of temperature; and the meteorologist, eternally distracted by the hourly irregularities of his elusive goddess, begins to wonder whether her pattern of behaviour can be led to display a major alteration through gentle persuasion or through sudden blows.

Opening the meeting, Mr. Seligman referred to the need for further work on the causes of changes in world glaciation, whether within the earth's system or without, and directed attention to Dr. H. W. Ahlmann's emphasis on the great value of such studies in the interrelation of the sciences. A large and highly diversified audience attended; but it became evident that co-ordination of the approaches made by workers in several fields is still not easy, and a two-hour meeting on such a vast subject could but leave the appetite whetted.

Prof. Zeuner began by very appropriately stressing the need for further collection of facts. He believed that the integration of evidence both in space and time is first necessary, and the new techniques of dating successions for purposes of correlation are still in an early stage. He demonstrated the complexity of the problem of glaciation in relation to the evidence for eustatic changes of sea-level in the Pleistocene in those areas which might reasonably be deemed free of isostatic complications. Quite apart from the effects of the several successive phases of the Ice Age, there appears to have been an overall lowering of sea-level during the past million years or so throughout southern and south-western Europe[1]. If that is so, the relationships between large-scale terrestrial changes, presumably of tectonic origin, and glaciation is not simple and requires further elucidation. With the aid of a diagram he pointed out that in the Post-Glacial the prevailing rate of fall of sea-level relative to the land underwent what might perhaps be rhythmic fluctuations with a period of the order of 1,800–2,000 years, a fact deduced from close studies of the Thames terraces and of numerous beach-levels[2]. The relationship of such fluctuations to variations in the tectonic forces at work or to variation in the rate of melting of ice-caps is still open to discussion.

Dr. Wiseman gave a brief but critical account of the recent results he and his colleagues have obtained from a close study of cores, collected in the equatorial Atlantic Ocean by the Swedish Deep-Sea Expedition, 1947–48, under the leadership of Prof. Hans Pettersson. Although Dr. Wiseman has recently published a preliminary paper[3], work is still in progress and some exciting glimpses of these new results were given to the meeting. It is apparently possible, in suitable deep-sea cores where specified conditions have been satisfied, to determine the past temperature changes in the upper layer of the sea by three different methods.

The first method is to determine the mass contribution of calcium carbonate per c.c. per year in a series of sections throughout the length of the core; the second method is to determine the species distribution of planktonic foraminifera; and the third to determine the oxygen-18 content in specific planktonic foraminifera. A core nearly 14½ m. in length has been investigated at every 5 cm., and more detailed investigations have been carried out on a series of sections taken continuously down a short pilot core. The graph showing the yearly mass of calcium carbonate deposited per c.c. in the short pilot core shows a series of minor oscillations superimposed on a major curve. There is an apparent correlation between these minor oscillations and the known minor climatic oscillations of more temperate regions. Dr. Wiseman pointed out that the conclusions arrived at from the rate of sedimentation of calcium carbonate were supported by the species distribution of planktonic foraminifera as well as by the oxygen-18 determinations on specific planktonic species carried out by Dr. Emiliani. For example, where the yearly rate of sedimentation of calcium carbonate is relatively high—namely, 990 μgm./sq. cm.—the calcareous tests of *Globigerinoides sacculifera* were apparently deposited at 24·3° C., while at a depth of 26·3 cm. from the top of the core where the yearly rate of sedimentation of calcium carbonate has fallen to 330 μgm./sq. cm. the tests of *Globigerinoides sacculifera* were deposited at 20·1° C.

Dr. Wiseman has found it possible to make age determinations by three different methods. The sources of error were briefly mentioned, and much work has and is still being carried out to show the justification of certain basic assumptions. It is of great interest to note that the minor oscillations in the rate of sedimentation of calcium carbonate are apparently synchronous with the minor climatic oscillations of more temperate latitudes. For example, at a depth of 22·4 cm. corresponding to an age of 9300 B.C., there is a minor oscillation in the rate of sedimentation of calcium carbonate. This oscillation would seem to be synchronous with the Allerød oscillation in Denmark[4], the age of which

according to recent carbon-14 measurements is 8800–9900 B.C.

Dr. Wiseman stressed the necessity for more work of this nature, and was careful to point out that the techniques used are not applicable to all cores, but can only be used where suitable conditions of sedimentation have existed. Finally, he showed a chart giving the many localities in the Atlantic where foraminiferal analysis has revealed cooler conditions in the past in the upper layer of the sea; and he pointed out that in four nearby cores collected from the Equatorial Atlantic, Dr. D. B. Ericson[5] has recently been able to make correlations from core to core and has concluded that the deposition is continuous and normal, and that there is no obvious evidence of turbidity currents, erosion, slumping or re-worked older sediments.

Prof. Manley emphasized the need for more attention not to the mere existence of ice but to the changes in its extent. Referring to the advances and retreats during the past three centuries, it is clear that a marked degree of parallelism existed around the North Atlantic, shown by the series of curves from numerous sources in several countries which have been assembled by Dr. H. W. Ahlmann in his recent Bowman Lecture[6]. With a further diagram he showed that the overall agreement between the fluctuations of the southern Icelandic glaciers and what is known of the fluctuations of the mean summer temperature in England is temptingly attractive. The eccentric position of the Pleistocene glaciation in the northern hemisphere on either side of the Atlantic suggests that the key to the greater events of the past may well lie in studies around that ocean. Whatever other causes are sought, changes in the configuration, depth and surface temperature of the North Atlantic are still deserving of further consideration, and Prof. Manley said that he was glad Prof. Zeuner had directed attention to the same problem in another way. He went on to demonstrate the minor irregular fluctuations of the order of two to three decades in length which have also been recognized in tree-ring series and other annual deposits. While these may reflect small changes in the character of the general circulation of the atmosphere, they have all occurred in the presence of a warm North Atlantic. The greater phenomena of the past and especially the low snow-line in the Ice Age require a much cooler ocean off north-western Europe[7]; and, as the development of the greater glaciations took a long time, perhaps of the order of two to three thousand years, the sea surface must have been cooled well before the maximum of glaciation, and we should decide how this could happen. He gave reasons for the opinion that each of the minor Late-Glacial re-advances in Britain was preceded by a fall of temperature of the same order as that which sufficed for the maintenance of maximum glaciation, but lasting for a much shorter time. A very rough calculation based on the size of the revived Post-Allerød glaciers in the Lake District in England appears to indicate that fifty to a hundred years would suffice for the re-advance, after which the ice lasted for four centuries or so. It would therefore appear that each of the changes in glaciation represented by advance could have taken place relatively rapidly and that they were succeeded by a much longer stage of stagnation or slow retreat. If that were so, we are faced with the problem of explaining why the pattern of the world's atmospheric circulation could be displaced, or biased, from its present state for varying lengths of time, and why patterns which are now merely ephemeral could become more persistent.

Mr. Hoyle developed a new line; he thought that the change in the amount and character of world glaciation in the period from the Late-Glacial to the Climatic Optimum represents a climatic change so remarkable as to be outside the operation of the earth's meteorological system. Astronomers are not happy about such rapid changes in solar variation, and he referred to the other type of external influence which might result from local variations in the density of interstellar matter between sun and earth. Such effects, which he had outlined in earlier discussions[8], are now calculable and cannot now be allowed as sufficient. Solar radiation might otherwise become intensified by the picking-up by the sun of material from interstellar clouds; but as the sun would need to move very slowly through such clouds it would not be able to do so sufficiently often to explain the observed effects. He thought that the recent work by Dr. E. G. Bowen in Australia[9] reopens the position completely. Bowen has studied the remarkable tendency for intensification of rainfall on certain days of the year in Australia; this is now confirmed elsewhere in the southern hemisphere, and also in Britain, and it is also related to the observations of noctilucent clouds. The possibility exists that this results from the provision of nuclei arising from the incidence of showers of meteoric dust at particular seasons and falling to the right levels. Mr. Hoyle therefore suggested that one of the most satisfactory ways of changing climate would be to tamper with the 'greenhouse effect' through knocking out some of the water vapour; and that the necessary material might be provided by the breaking-up of a particularly large comet. The figures for the mean mass of comets are, he said, in agreement with this possibility, and the particles providing the zodiacal light are of the right size. Alternative explanation can still be sought in changes of the rate of movement of a gas passing through the solar system.

Subsequent speakers were much exercised by Mr. Hoyle's suggestions, and Mr. D. J. Schove asked if any evidence could be obtained from deep-sea sediments of variations in the abundance of such meteoric material. Dr. Wiseman replied that work is in progress on the nickel and cobalt content of deep-sea cores, and it is hoped that it will shortly be possible to decide whether the nickel was or was not of cosmic origin. Mr. E. Gold asked if anything is known of the effects of other meteoric streams—for example, those in August—and thought there is very little water vapour at the great heights mentioned; Mr. Hoyle thought that the time of sinking of the fine particles through the atmosphere might vary and could be of the order of twenty days.

The discussion was perforce, like many of its kind, inconclusive; but the numerous problems brought to light go far to show that although the issues are being gradually narrowed we still need more exact knowledge of what we are trying to explain; and, indeed, the problem of climatic change is increasing in complexity. Prof. Zeuner's contribution calls to mind the need to avoid the uncritical reliance on the results of changes in the extent of land and sea and of the relief in high latitudes; subsequent re-emphasis of the character of the open North Atlantic in relation to the location of the continental ice-sheets raises the question of how, and over what

length of time, cooling took place, an answer to which must await the work of Dr. Wiseman and his colleagues. There is evident need for further investigation of the extremes of climatic displacement which have resulted at various times in different parts of the world. The fact of the snow-line having been by no means uniformly lowered over the world as a whole, and the very variable length of the glacial phases, needs further study. The meteorologist is well capable of outlining pressure maps for the Ice Age; the importance now lies in the process by which transition was effected, and further evidence, from the field sciences, of the time required for such transitions may enable the meteorologist to provide an answer. The challenge of Mr. Hoyle's statement, that the change from Glacial to Climatic Optimum lies outside the operation of the earth's meteorological system, is one which will unquestionably stimulate further thought. Even the man of science on his Alpine holiday can reflect upon the conspicuous results of the seventy-odd years of decline of the Rhône glacier as a possible portent.

Gordon Manley

[1] Zeuner, F. E., "The Pleistocene Period", p. 250 (1945).
[2] Zeuner, F. E., "Dating the Past", 1st ed., p. 93 (1946). Florin, S., *Geol. För. Stockholms Forh.*, **70**, 17 (1948).
[3] Wiseman, J. D. H., *Proc. Roy. Soc.*, A, **222**, 296 (1954).
[4] Iversen, J., *Science*, **118**, 9 (1953).
[5] Ericson, D. B., Tech. Rep. Submarine Geol., No. 1, Lamont Geol. Obs., 1 (1953).
[6] Ahlmann, H. W., "Glacier Variations and Climatic Fluctuations" (Bowman Lecture, No. 3). Amer. Geog. Soc., N.Y. (1953).
[7] Manley, G., *Geogr. J.*, **117**, 43 (1951).
[8] Discussion on Post-Glacial Climatic Change, *Quart. J. Roy. Met. Soc.*, **75**, 161 (1949).
[9] Bowen, E. G., *Aust. J. Phys.*, **6**, No. 4, 490 (1953).

NEW INSTITUTE OF CLINICAL SCIENCE AT THE QUEEN'S UNIVERSITY, BELFAST

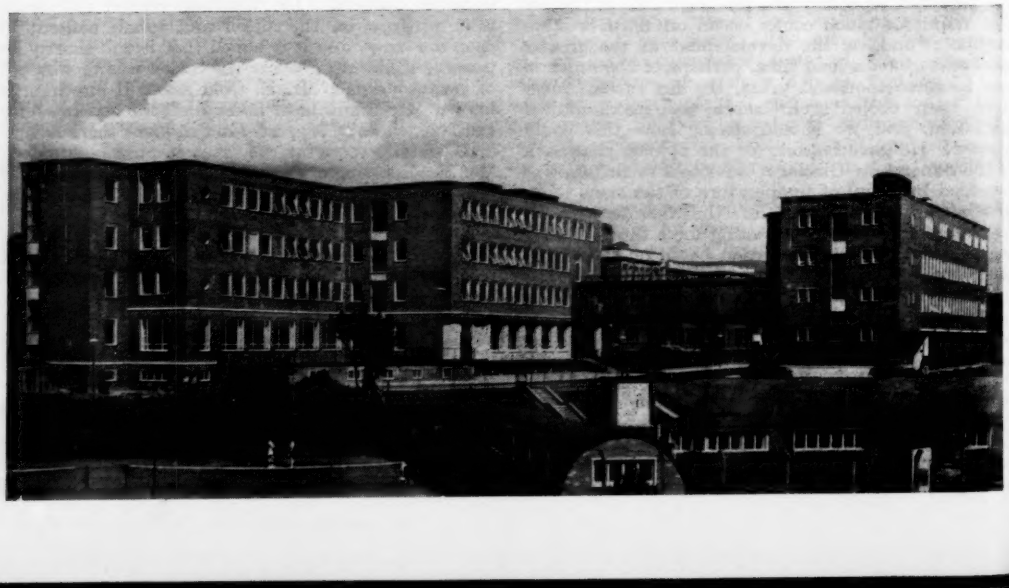
THE Institute of Clinical Science of the Belfast Medical School was opened recently on behalf of the Duchess of Gloucester by Lord Wakehurst, the Governor of Northern Ireland. The purpose of the new Institute is to provide additional room for teaching and to increase the research facilities of the school. Owing to certain building restrictions, it was necessary to divide the building so that the Institute consists of two buildings united by a closed-in bridge.

The west block contains two large lecture theatres capable of seating 282 and 221. In these, special attention has been given to acoustics, and a very efficient and pleasing result has been obtained. They are mechanically ventilated and furnished with modern projection apparatus of various types. Teaching facilities are also supplied in eight tutorial rooms, each capable of seating thirty students, and furnished with projection and other apparatus for demonstration. The west block also contains the Departments of Therapeutics, Obstetrics and Gynæcology, Child Health and Social and Preventive Medicine, as well as a photographic unit and an artist's studio.

The Medical Library is also in the west block. It has been provided as a War memorial, and in addition to the main reading rooms has three separate reading rooms for undergraduates, postgraduates and staff, which serve as memorials to three young graduates who fell in the Second World War. These rooms are panelled in various woods, and the main room contains six paintings by Mr. Norman Wilkinson, depicting the counties of Northern Ireland. This building is linked to the Institute of Pathology and to the teaching wards of the Royal Victoria Hospital.

The east block contains the Departments of Medicine and Surgery. The third floor is designed for experimental research. Each member of staff has a private laboratory, while in addition each department has at least one communal laboratory. A great deal of thought has been given to the services for the whole building, and these are carried in the ceilings of the corridors; but they are readily accessible above the false ceilings and can be easily expanded to meet further developments. This distribution of the services renders maintenance a relatively easy matter.

The link with the hospital, and the provision of lifts, render it possible for a patient in bed to be wheeled to any floor for detailed investigation.



The architects have been successful in producing a pleasing exterior by using multicoloured Ravenhead russet brick and Portland stone. The windows, which are double for heat conservation, are in good proportion to the mass of the building. In all, the architects have succeeded in their aim and have provided a dignified building for the undergraduate, and excellent accommodation and facilities for the research work of the staff.

THE TWO VISCOSITIES OF FLUIDS

A ROYAL SOCIETY discussion on "The First and Second Viscosities of Fluids" was held in the rooms of the Society, Burlington House, on April 29.

The discussion was opened by Prof. L. Rosenhead (Liverpool), who reviewed the fundamental facts and concepts. The generally assumed relationships between the stresses and rates of deformation in a homogeneous fluid lead to equations such as:

$$p_{xx} = -p + \mu'\left(\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z}\right) + 2\mu\frac{\partial u}{\partial x}, \quad (1)$$

$$p_{yz} = \mu\left(\frac{\partial v}{\partial z} + \frac{\partial w}{\partial y}\right), \quad (2)$$

where u, v and w are the components of velocity referred to fixed orthogonal axes Ox, Oy, Oz; p_{xx}, p_{yz} components of the stress tensor, μ the first (or shear) coefficient of viscosity and μ' the second (or dilatational) coefficient of viscosity. The combination $(\mu' + \frac{2}{3}\mu)$, denoted by $\varkappa$, is the bulk viscosity.

The physical meaning of μ is evident from equation (2), but that of μ' depends on the interpretation of p in equation (1). In the past the bulk viscosity has either been ignored, for which there is some justification if incompressible fluids are being considered, or it has been assumed to be zero, which is true if p is equal to $-(p_{xx} + p_{yy} + p_{zz})/3$. If, however, p is not equal to this last expression, there is no *a priori* reason for assuming $\varkappa = 0$, and its actual value (and hence the value of μ') is open to experimental investigation for any given interpretation of p. Up to the present, the value of $\varkappa$ has not been measured directly, but values of $\varkappa/\mu$ have been deduced independently from the results of two different types of experiment—the absorption of sound-energy and the determination of the speed of acoustic streaming. In both cases p is taken as the thermodynamic pressure, defined at constant entropy as a function of ρ. The former type of experiment is well established, but the latter field was opened up recently by the theory of Eckart[1] and the experiments of Liebermann[2]. Liebermann concluded that there is reasonable agreement between values obtained by the two techniques. It was found that, at megacycle frequencies, $\varkappa/\mu$ is nearly zero for gases and liquefied gases, is 'small' (say 0–5) for bonded liquids, such as water and the alcohols, is larger (5–20) for most organic liquids and largest for a group of non-polar liquids including carbon tetrachloride, benzene and carbon disulphide. The last-named substance has the highest known value with $\varkappa/\mu = 200$ at room temperatures.

These facts, however, merely provide a start, and a number of problems remain. From equations (1) and (2) it can be deduced that the sound absorption coefficient α is proportional to the square of the frequency. This is not always found (for example, with carbon disulphide and acetic acid), and deviations are often explained in terms of a 'relaxation' theory. What then is the significance to be attached to p and μ' in equation (1), and how is the theory of acoustic streaming to be modified? Further, there is some doubt about certain aspects of the technique employed by Liebermann for measuring the streaming velocities; this is partly connected with questions of interpretation of results and partly with difficulties intrinsic in the technique.

Experimental questions concerning acoustic streaming were discussed by E. G. Richardson (Newcastle upon Tyne). He recalled that streaming was first recorded with sonic sources by Dvořák[3] and afterwards investigated by Rayleigh[4], Andrade[5] and Schlichting[6], who showed that at low frequencies the effect is due to vorticity generated in the boundary layer. Under these conditions recent experiments at Newcastle show that, if the temperature is varied, streaming appears to increase with decreasing viscosity. This also appears to remain true in the megacycle region, even for substances with large bulk viscosity. It was said that dissipative heating of the medium seems to be due to shear viscosity only, and that experiments on absorption of sound in capillaries can be explained in terms of the boundary effects, which are due only to shear viscosity. Richardson suggested that in view of the high vapour pressures of substances with large bulk viscosity, the possibility that cavitation plays a part in the streaming should be kept in mind. In connexion with this point, Prof. P. Biquard (Paris) remarked that, in order to investigate the effect of pressure and the possible effect of cavitation, he has experimented with various liquids at pressures up to about 100 atmospheres by measuring the scattering of light. The results show that absorption of energy under pressure can be accounted for quite simply by taking into account the percentage variation of viscosity with pressure. The question was also raised as to whether the absorption coefficient depends on the amplitude of the source and the hydrostatic pressure. The replies seemed to indicate that the reported measurements made with continuous waves, using pressure-vane techniques, do show a variation with amplitude, but those made with pulsed waves do not. Increase of pressure has been observed to diminish the absorption in carbon tetrachloride and toluene; but this may be ascribed, in part, to changes in the first coefficient of viscosity and the velocity of sound, both of which enter into the Stokes absorption formula.

S. M. Karim (Karachi) mentioned the work he has recently carried out on the Liebermann type of experiment. He pointed out that the values obtained for μ'/μ sometimes appear to depend on the intensity of the sound beam, probably on account of the development of turbulence. Further, the choice of the ratio of the diameter of the sound beam to that of the tube influences the experimental results. Additional detailed experimental work is required before firm conclusions can be drawn.

The difficulties of separating boundary layer effects from Eckart streaming were emphasized by P. E. Doak (Manchester), who went on to show how Eckart's original theory can be extended to deal with relaxing media while still neglecting boundary effects. He reached the conclusion that, apart from a term in the viscosity gradient, the streaming velocity is in all cases proportional to the coefficient

of sound-absorption. Further, it appears that the streaming is generated by interaction between the stationary and the radiative parts of the acoustic field. If either should disappear, or if the motion is one-dimensional, no streaming is possible. Although this work was based on the notion of vorticity sources, the conclusion concerning the role of sound absorption was also demonstrated by J. E. Piercy and J. Lamb (London). They considered the propagation of a sound beam along the axis of a tube. Due to attenuation, there will be a gradient of radiation pressure proportional to the absorption coefficient, and this can be taken as a body force acting on the fluid—which can now be regarded as incompressible. Starting from this point of view, the velocity profile can be found explicitly in mathematical form. Apparatus embodying this principle has been constructed; it aims at a direct measurement of the radiation pressure of the beam, together with a measurement of the pressure-head generated by a known length of beam. Preliminary measurements at 1 Mc./s. and 25° C. show excellent agreement with other techniques for relative values of $(\alpha/f^2) \times 10^{17}$ ranging from 24 (water) to 5,500 (carbon disulphide).

Both P. E. Doak and R. O. Davies (London) emphasized the fact (due to Mandelstam and Leontovich[7]) that there is no way of distinguishing the effects of a bulk viscosity and a relaxation process associated with frequencies much higher than those of the experiment. The latter author formulated equations of hydrodynamics applicable in a relaxation region and developed the plane-wave solution in order to demonstrate the conclusion just noted. He showed that the presence of relaxation modifies the classical contributions to absorption due to thermal conductivity and shear viscosity. Apart from relaxation associated with intra-molecular vibrational motion (which seems to be present in all liquids with $\varkappa/\mu > 20$) there are contributions to the absorption coefficient due to structural changes and shear relaxation which can be investigated experimentally only by working at frequencies comparable with the inverse Maxwell relaxation time.

This aspect of the problem was elaborated by J. Meixner (Aachen), who showed that a liquid can be considered as the limiting case of an elastic body with 'after-effects'. The after-effect theory, when applied to a generalized stress–strain relation containing temperature and entropy, yields an apparent viscosity matrix whose main components become the first and second viscosity coefficients when the substance is isotropic. It is only under certain restrictions that arbitrary after-effect behaviour can be represented as a thermodynamic relaxation theory. When these restrictions are satisfied, parameters referring to shear and volume changes can be separated.

Underlining the fact that stationary transport is to be considered as a limiting case of relaxation, H. O. Kneser (Stuttgart) discussed shear flow and volume flow in gases. In the former case momentum parallel to a wall moving in its own plane is transferred perpendicularly to it with no energy change. The relaxation time is therefore comparable with the collision time and has not yet been observed. When, on the other hand, the wall moves perpendicularly to itself, momentum transfer is coupled with energy transfer and the attainment of a stationary state may be delayed if the molecules have internal mechanisms for storing energy.

J. H. Andreae (Welwyn) and J. Lamb reported further details concerning the intra-molecular relaxation of carbon disulphide centred around 75 Mc./s. at 25° C. and 31 Mc./s. at − 63° C. They gave a relaxation theory of absorption involving an arbitrary number of relaxation processes, and then separated effects due to relaxation times much larger and much smaller than the inverse frequency-range of interest. It was suggested that the total magnitude of the volume relaxation still remaining unexplained at 200 Mc./s. can be estimated by assuming that for $f \to \infty$, $C_p \to 5R/2$ and $C_v \to 3R/2$.

Adopting an approach different from that of both the thermodynamic and the molecular theories, Sir Geoffrey Taylor presented a simple mathematical model which exhibits characteristics of a bulk viscosity. He supposes that small gas bubbles are dispersed in an incompressible liquid of shear viscosity μ, thus making the medium as a whole slightly compressible. The contraction and expansion of the bubbles are resisted by the viscosity of the surrounding fluid, and it is found that the second coefficient of viscosity is $4\mu/3v$, where v is the (small) proportion of the total volume occupied by the bubbles.

J. G. Oldroyd (Swansea) said that the quantities p and μ' in the basic equations of Prof. Rosenhead's presentation can, in certain special circumstances, be given precise meanings; but this involves the assumption that the values of the quantities are their 'instantaneous' ones.

In summing up the discussion, Prof. E. N. da C. Andrade remarked that the last time he had heard of the second coefficient of viscosity was when he was a student. The late Prof. Karl Pearson had introduced it into his lectures—only to evict it as quickly as possible; it now appeared to be a topic worthy of serious consideration. He pointed out that the second coefficient (μ') has not been defined in a physical way. But the bulk coefficient ($\varkappa$)—the quantity used by Sir Geoffrey Taylor in his contribution—is so defined. A method of measuring μ' directly is very desirable. The experiments which had been described fell into two classes—those concerned with absorption and those concerned with streaming. From these the ratio μ'/μ has been determined. It is clear, he said, that there are two types of streaming: the type investigated by Schlichting, Andrade and others, and the type which the Liebermann experiment was designed to investigate. There are a number of faults in Liebermann's apparatus, however, which seem to have been eliminated in the excellent experiments of Piercy and Lamb. Richardson had noted that, of the various liquids he used, the five which exhibit marked streaming also possess higher vapour pressures. It appears to be more significant, however, that four of these liquids are non-polar while the fifth possesses only a small dipole moment. As regards absorption of energy in experiments in capillary tubes, Richardson had mentioned that it seems to be chiefly explained by the first coefficient; but this is to be expected, since the skin-friction effect, which involves shearing motion, will predominate in the experiments, so that the second coefficient will not be able to play a large part. The discussion had clarified the two theoretical methods of approach (one based on a formal mathematical presentation and another based on the physical relaxation theory), and it may now be possible to present relaxation theories in terms of formal mathematics. It does not appear strange, he said, that we understand so

little about the second coefficient of viscosity when we realize how little we know about the first. We appear to be at the beginning of a very important study of the internal vibrations of molecules, leading, it is hoped, to a clarification of the fundamental concepts of fluid dynamics. Prof. Andrade stressed the importance of choosing the best fluids for experimental and theoretical work; water is most unsuitable, as it has a wide variety of abnormal characteristics.

A full report of the meeting will appear in the *Proceedings of the Royal Society* in due course.

R. O. Davies
L. Rosenhead

[1] Eckart, C., *Phys. Rev.*, **73**, 68 (1948).
[2] Liebermann, L. N., *Phys. Rev.*, **75**, 1415 (1949).
[3] Dvořák, V., *Pogg. Ann.*, **157**, 61 (1876).
[4] Rayleigh, Lord, *Phil. Trans. Roy. Soc.*, **175**, 1 (1884).
[5] Andrade, E. N. da C., *Proc. Roy. Soc.*, A, **134**, 445 (1932).
[6] Schlichting, H., *Phys. Z.*, **33**, 327 (1932).
[7] Mandelstam, L. I., and Leontovich, M. A., *J. Exp. Theor. Phys. USSR.*, **7**, 438 (1937).

OBITUARIES

Dr. E. M. Elderton

Ethel Mary Elderton was born on December 31, 1878, and died on May 5, 1954. She entered Bedford College for Women in 1895 in the Faculty of Arts and went down in 1899 without having sat for a degree. University was followed by a period of teaching; but the real pattern of her life-work did not emerge until about 1905, when through Alice Lee she worked first for Leonard Darwin and then for Francis Galton, being made secretary of the Eugenics Record Office in 1906. From this modest beginning she became successively Galton Scholar, Galton Fellow, assistant professor and reader in eugenics in University College, London (1931). She retired in 1935.

During the whole of the period in which she was either attached to, or a member of, University College she was actively engaged in both teaching and research. At the College she was a member of a research team headed by Karl Pearson, and as such much of the work she did was contained in the co-operative effort; but evidence that she was capable of a sustained piece of individual research will be found in such a memoir as "Report on the English Birth Rate 1914", to quote only one of a number of publications with a eugenic flavour.

As a person she was delightful, as an expositor she was unrivalled for clarity of thought and lucidity of expression, and as a teacher she had the rare gift of enthusiasm and the ability to impart it to others. There must be many to-day who owe to her their first steps in statistics and the knowledge and self-confidence that things were not so difficult as more mathematically minded teachers had made them appear. Her essential modesty hid an ability which caused the first Galton Fellow to write in 1906: "Miss Elderton has certainly been a remarkable success at the Eugenics Office; but I think her marvellous energy and quickness to learn anything new would have enabled her to succeed at anything she undertook".

Her work was recognized by the award of the Weldon Medal in 1919, and in December 1931 the University of London conferred on her the degree of D.Sc.

F. N. David

Dr. W. T. Mathias

William T. Mathias, lecturer in botany in the University of Liverpool, suffered a heart attack in his laboratory on May 19, and died in hospital an hour or so later. This was a severe blow and shock to his family and friends, for only the previous day he had taken the senior students on a field excursion to North Wales.

He was born in Cardigan, South Wales, in 1900, and graduated in agriculture from the University College, Aberystwyth, in 1922. He then specialized in botany. Although offered a scholarship for research at Oxford, he chose to go to Bangor as an assistant lecturer under Prof. D. Thoday; but a year later, in 1924, he moved to the Botany Department of the University of Liverpool. His early training under Prof. Lloyd Williams led to an interest in the problems associated with the life-cycles of marine algae, and Mathias's published researches on *Callithamnion* and *Phloeospora* were in this field. For some years past he had been making a similar study of *Chordaria*.

Mathias was an enthusiastic and willing teacher, and always carried a large share of the teaching load of the Department. He took an active part in extra-mural work and in school examining, still finding time to help and encourage amateurs in their field collecting. He was for some years secretary of the University Military Education Committee, and took a very keen interest in the welfare and progress of the units associated with the University.

He is survived by a widow and two children; in 1931 he had married Miss Jane Evans, who was one of his former students at Bangor.

Alan Burges

NEWS and VIEWS

The Kalinga Prize: Mr. Waldemar Kaempffert

This year the Kalinga Prize, which is awarded annually by a panel of judges appointed by Unesco, has gone to Waldemar Kaempffert, who has been science editor of the *New York Times* since 1927 except for the short spell which he spent as director of Chicago's Museum of Science and Industry. Born in New York City in 1877, he is universally regarded as the dean of American science writers. His long and distinguished career has included the editorship of *Scientific American* and *Popular Science Monthly*. He has written a number of books; but by far the most important part of his life's work has been his writing for the *New York Times*, his regular articles in the *Sunday New York Times Magazine* being particularly popular among laymen and scientists alike. "Current Biography" has justly summed up his career in these words: "No one has done more to bridge the gap between the abstract hypotheses of the laboratory and the mind of the common man". The award will be accepted everywhere as an excellent choice and as a tribute to the great importance of the profession of science writing nowadays. It reflects

the change in the conditions of award whereby the Kalinga Prize now becomes a mark of recognition for "a distinguished career of public service in the interpretation of science". It is interesting that the nomination which brought Mr. Kaempffert's name before this year's judges came from the Association of *British* Science Writers, which exists to improve the standards of science writing in Great Britain. Mr. Kaempffert's views on the present state of the press relations of science were vigorously expressed in a recent number of the *Bulletin of the Atomic Scientists* (November 1953) in an article headed "Neither is Perfect".

Department of Genetics of the University of Sheffield

The recent establishment of a separate Department of Genetics in the University of Sheffield is the logical development of the stimulus given to this subject in the Departments of Botany and Zoology when Dr. J. M. Thoday was appointed as lecturer in cytogenetics in 1947. In addition to the immediate impact of the teaching of genetics on the two parent Departments, the subject has an increasing importance in shedding new light on biological problems at all levels. This has been emphasized by courses given in medical and microbiological departments and by the steady growth of a thriving research school. The independence accorded to genetics in Sheffield now makes possible extensions into wider fields without interfering with the teaching of genetics as hitherto to students of botany and zoology. While Dr. Thoday's research interests are varied, they have perhaps expressed themselves most prominently in investigating the effects of ionizing radiations on chromosome structural changes and the further influence of environmental factors on the frequency of these changes. In setting up the new Department, the University has recognized the rightful independence of a subject which cuts across the formal frontiers of long-standing subjects like anatomy, botany, physiology and zoology. That it has been thought fit to appoint Dr. Thoday as senior lecturer in charge is a testimony to his ingenuity as a research worker, his inspiration as a teacher and his insight as a supervisor of research.

Centenary of Boole's "The Laws of Thought"

The centenary of the publication of the "Laws of Thought" by George Boole was celebrated at the Royal Irish Academy, Dublin, during May 24–25. The "Laws of Thought" was published in 1854 while Boole was professor of mathematics in Queen's College, Cork; but his association with the Royal Irish Academy had begun ten years earlier when his friendship with the Rev. Charles Graves led him to use the *Proceedings* and *Transactions* of the Academy as a medium for the publication of some of his papers. At the recent meeting in Dublin the guests included Prof. L. E. J. Brouwer (Blaricum, Holland), T. L. Craven (Automatic Telephone Co., Liverpool), W. C. Kneale (Exeter College, Oxford), Rush Rhees (University College, Swansea), Prof. J. B. Rosser (Cornell University), Sir Geoffrey Taylor, and the Rev. Ivo Thomas (Hawkesyard Priory, Staffs). The afternoon of May 24 was devoted to a formal celebration, when Sir Geoffrey Taylor, a grandson of Boole, spoke on George Boole and his family connexions, and the Rev. Canon Feys gave an address entitled "Boole's Achievement in Developing Symbolic Logic". On the morning of each day there was a technical session at which the following papers were read: F. E. Hackett, the Method of George Boole; J. B. Rosser, Boole and the Concept of Function; T. L. Craven, Boolean Algebra and Switching Current Design; Rev. Ivo Thomas, Boole's Concept of Science; Rev. Canon Feys, Boole's Technique in the "Laws of Thought"; Michael MacConaill, the Likeness of Correlated Relations; and L. E. J. Brouwer, the Effect of Intuitionism on the Classical Algebra of Logic. These papers will be published in a special issue of the *Proceedings* of the Academy.

Artificial Stimulation of Rain

In the House of Commons on June 15, Mr. Geoffrey de Freitas asked the Under-Secretary for Air whether the physical sub-committee of the Meteorological Research Committee had yet considered the problem of weather modification; and what conclusions it reached. This matter had been raised earlier by Mr. de Freitas (see *Nature*, March 13, p. 474). Mr. George Ward, in a written reply, stated that the committee had recently considered this subject and come to the conclusion that there is no reliable evidence that rainfall has ever been artificially increased on an economically useful scale, and that there is no scientific basis for believing that any method yet proposed would be successful in achieving such a result. Since there is so much at stake, however, the committee considers that scientifically conducted research should be intensified, particularly into the large-scale diffusion of airborne particles, the analyses of natural nuclei concentrations and the design of the large-scale field trials which would be necessary to test the effectiveness of the proposed methods of operation. The Meteorological Office is putting in hand the studies recommended by the sub-committee.

Research and the Future of the World

In an address entitled "Today's Research and Tomorrow's World" to guests of the board of directors of the Stanford Research Institute at Los Angeles on January 20 (pp. 16. Washington, D.C.: Carnegie Institution of Washington, 1954), Dr. Vannevar Bush, reviewing the possibilities of atomic warfare which confront us, said that whatever the future has in store, whether an atomic war, a long stalemate or a gradual transition to a more salutary position, for the present we should, by creating strength in the free world, seek to maintain peace and postpone a fully developed impasse. One phase of this, he said, involves building an adequate defence system for the North American Continent, which at present is nearly wide open to aerial attack. This lack of balance is due chiefly to two reasons: first, it has only fairly recently, through technical advances, been possible to ensure a reasonable and economic degree of protection, sufficient to raise doubt in the mind of an enemy as to the success of a single surprise attack; secondly, the national military planning organization is short of the sound integrated system essential for national safety. In Dr. Bush's opinion, the United States could have a defensive system which is worth while, without unduly burdening its economy or unwise sacrifice of any other element in its military preparedness, and should insist on having it and the improved military planning. After referring also to the need to make its system of democracy work and maintain vigorously some of its ideals of freedom, Dr. Bush turned to some of the trends in research and development which offer new hope. The blos-

soming of the biological sciences and their application in agriculture, the opening-up of arid areas by solar power, new methods of sterilizing and packaging, etc., offer prospects of a breathing space from the pressure of increase in population. Chemical control of mental disease might be a powerful weapon in the war against man's ills. Progress is also being made in the handling of giant molecules, which require a new type of chemical thinking. There have been great strides in the development of machines for supplementing and substituting human thought; but this process needs to go much further before we can cope with the complexities of the coming world. Dr. Bush referred specifically to problems of communication in which new techniques of electronic selection, photomicrography and facsimile transmission would replace the conventional library. There is, however, a reason for the search for knowledge which is inherent in the nature of man. His search for understanding is prompted not simply by his immediate needs for food and shelter, but also by his inherent urge to know. Science should be pursued, Dr. Bush concluded, in response to the urge which lies deep in all of us to press on towards greater understanding.

The National Research Development Corporation

In the debates on the Development of Inventions Bill and again in the recent report on industry and science issued by the Manchester Joint Research Council, opinion was expressed that the work of the National Research Development Corporation is not sufficiently well known in industry. The *NRDC Bulletin*, of which the first number appeared in April (No. 1; pp. 20; 1954), is an attempt to remedy this position by informing industry of the inventions which can be made available by the Corporation in addition to, or in place of, the existing routine circulation procedure. It is hoped that in time the *Bulletin*, which will be published quarterly, will become the Corporation's chief vehicle for informing industry of such inventions. Each issue will include short notes of the inventions recently available, as well as on other inventions which have been the Corporation's property for some time and which it is considered should receive wider publicity. It is also proposed that each issue shall contain at least one article about other aspects of the Corporation's activities. Besides the descriptions of selected inventions, the present issue includes a note on the granting of licences and a list of the Corporation's patent holdings, arranged in the eight groups: electronics; electrical engineering; mechanical engineering; civil engineering; aero and auto engineering; scientific instruments; chemistry and plastics; miscellaneous and domestic. The *Bulletin* is obtainable from the Exploitation Officer, NRDC, 1 Tilney Street, London, W.1.

Simultaneous Translation at a Scientific Meeting

On May 11, at a meeting held at the Institut Pasteur in Paris, Prof. J. H. Quastel, professor of biochemistry in McGill University, Montreal, delivered by invitation an address on "Soil Metabolism". The occasion was noteworthy for the use of a system of simultaneous translation, analogous to that used at meetings of the United Nations and similar bodies. Thus Prof. Quastel delivered his lecture in English, and the difficult task of simultaneous translation was carried out by Dr. P. R. Lépine, of the Institut Pasteur. Dr. Lépine had actually seen Prof. Quastel's manuscript for a short time before the meeting; it was nevertheless a considerable achievement to be able to give a simultaneous translation of a scientific discourse in a way which the audience found to be completely successful. At the conclusion of the lecture, Prof. J. Trefouël, director of the Institut Pasteur, thanked Prof. Quastel and, as is customary when distinguished visitors address the Institut Pasteur, presented to him a silver medal, which bears a figure of Pasteur by the sculptor Roty.

Recognition of Intoxication

In a study of the chemical diagnosis of alcoholic intoxication (*S. Afr. J. Med. Sci.*, **18**, 141; 1953), J. J. Prag has attempted to correlate the usual clinical criteria of drunkenness with blood-alcohol levels. The tests were made on a hundred motor-car drivers, charged with driving under the influence of alcohol, and on a group of volunteers. One of his conclusions is that with blood-alcohol levels below 0·05 per cent (gm./per 100 ml.) nobody is intoxicated in the medico-legal sense, while with a level above 0·15 per cent most people (more than 90 per cent) are definitely intoxicated. The weakness of the chemical diagnosis lies in the blood-alcohol range between 0·05 and 0·15 per cent, where individual variations in symptoms are very great. The average ratio of blood-level to urine-level of alcohol was found to be 1 : 1·31, though the blood-level reflects more directly the alcohol concentration affecting the nervous system. With a given amount of alcohol, the greatest degree of intoxication is reached well before the blood-level reaches its maximum. If sugar is taken with alcohol, the symptoms are more severe but pass off more quickly, apparently owing to more rapid absorption and removal of alcohol. The results of this work are, on the whole, in harmony with the recent report entitled "The Recognition of Intoxication" by the Committee of the British Medical Association (1954) under the chairmanship of Prof. E. J. Wayne. Both Prag and the Committee stress that symptoms of impaired judgment may appear after drinking small amounts of alcohol and long before the stage of definite intoxication is reached. Diagnosis of drunkenness should not depend solely on results of laboratory tests, but on clinical findings, combined, if possible, with laboratory tests.

Tobacco Curing Studies

Biochemical and physical changes which take place in tobacco leaves during flue-curing are described in some detail by H. O. Askew *et al.* (*N.Z. J. Sci. and Tech.*, B, **35**, 4, 344; 1954). Data for changes in weight and moisture content of tobacco leaves during flue-curing show that the rate of loss of water is governed by the temperature and humidity conditions in the kiln. In the early stages of curing, 93–95 per cent of the loss of weight of the leaf is due to loss of water. During the colouring and fixing stages, rapid hydrolysis of starch to sugars, mainly glucose and fructose, and hydrolysis of protein-nitrogen to simpler compounds, take place. For the first 50 hr. of curing, the average rates of hydrolysis were: starch 0·35 per cent in two experiments; and protein-nitrogen 0·5 per cent and 0·7 per cent, respectively. Increase in reducing-sugars content was proportional to the amounts of protein and of starch hydrolysed. Loss of dry-matter can be nearly completely accounted for by requirements of water, by the products of hydrolysis, and by difference between over-all loss of starch and that required for

formation of soluble sugars. Internal transformations involving no losses of dry-matter may also have occurred. Variation in the contents of total non-volatile ether-soluble acids and malic acid was appreciable, but for oxalic and citric acids it was relatively small. Nicotine content did not vary during curing. No certain losses of total nitrogen were found. The *p*H value of the leaf did not vary. Neither soluble phosphate, soluble sulphur and protein–sulphur contents, nor soluble calcium content, varied during curing of the leaf.

Curing of Sheepskins in the Sudan

A LARGE-SCALE experiment on the curing of sheepskins has been carried out in the Sudan. The straight drying of sheepskins was compared with dry salting in the hot and in the cold seasons; drying in the sun was compared with shade-drying, and rope-drying with framing. At each season nine batches of fifty skins each were treated, the skins later being dressed in England as white suede. Straight drying gave almost consistently the best leather and cold season 'cure' was better than hot. Damage was found to be present in the raw skins although it could only be recognized microscopically. In its milder form it caused the grain to be rubbed off during processing or caused holes to appear in the skins; extreme damage led to complete disintegration and the skins dropped to pieces. It is suggested that an immediate improvement in the quality of 'curing' in the Sudan might be achieved by abandoning dry-salting, and by straight-drying the skins without delay, avoiding excessive heat in the direct sun (*Colonial Plant and Animal Products*, **3**, No. 4: 1952–53).

Formation of Asparagine in Lupin Seedlings

THE formation of asparagine in etiolated seedlings of *Lupinus albus* has been considered in some detail on the basis of analytical and experimental investigations by A. N. Meiss (*Bull. Connecticut Agric. Exp. Sta.*, No. 553, 1; 1952). In this bulletin recent work on the biochemistry of asparagine formation is reviewed, while in the experimental section the germination and growth of etiolated seedlings are described and comprehensive analyses of these materials submitted, reference being made to the nitrogen fractions, lipids, soluble and insoluble carbohydrates, organic acids, moisture and ash. In the discussion of the experimental data, the relation of asparagine accumulation and growth, the sources of the asparagine nitrogen and carbohydrate, and the role of the organic acids and mineral nutrients are considered. The principal conclusion which is drawn is that the large accumulation of asparagine in etiolated seedlings of *Lupinus* is a consequence of a normal, but obligatory, utilization of seed protein as a respiratory substrate. The asparagine which arises by secondary synthesis—in the *Lupinus* seedlings it is about 90 per cent of the total formed—is considered to be a product of protein respiration, and as such is not metabolized further until acute starvation conditions prevail. Other observations and results which are associated with this conclusion are set out and discussed in detail.

Growth of Excised Roots

IN one of a series of studies of the growth of excised roots in controlled aseptic culture, J. C. Skinner and H. E. Street have investigated the cultural requirements of a number of strains of *Senecio vulgaris* (groundsel), which also have been, and are being, studied genetically (*New Phyt.*, 53, 1, 44; 1954). Earlier work, in which it was found that excised roots of strains within a species may show clearly defined differences in their capacity for 'essential metabolite' synthesis, is reviewed. The underlying point of view in these new physiological-genetical studies is that more detailed examination of the differences in the growth requirements of different strains should enable a comparative physiology of excised root systems to be constructed. The differences observed in the growth responses of cultured excised roots of tomato strains to added B vitamins suggests that this technique may be used to advantage in the study of the genetical control of synthetic processes in flowering plants. Seeds of a number of geographical strains of *Senecio vulgaris* were available and excised roots have now been successfully cultured. The present paper gives details of a technique for the establishment and maintenance of excised root clones and describes the growth responses of one clone to a range of nutritive treatments. Subsequent work has involved comparison of the growth in selected culture media of the roots of a number of geographical strains and of hybrids between them, and study of the segregation of excised root characters in the F_2 generations of these crosses.

Flake-Tool Cultures in South Africa

AN article by Prof. T. F. Dreyer, entitled "The Origin and Chronology of the Fauresmith Culture" (*Res. Nat. Museum, Bloemfontein*, **1**, Part 3; 1953), makes an interesting suggestion as to the origin of the flake-tool cultures which appear with some suddenness at the end of Fauresmith times. The current view of many prehistorians in South Africa is that the Middle Stone Age complex (flake-tool industries) is directly derived from the Stellenbosch (core-tool industries), the Fauresmith being the latest of the Stellenbosch series. It is not easy to explain why this change should have taken place at the time it did and why the coups de poing which had persisted for perhaps scores of thousands of years throughout many changes of climate and conditions should have so rapidly disappeared and been replaced by others so completely different, unless influences from outside had operated. In Europe and northern Asia, where a similar phenomenon occurs, it can be shown from distribution maps that the flake-tool making cultures existed farther to the east contemporarily with the core-tool making people, and replaced them in western Europe towards the end of Würm I times. Prof. Dreyer suggests a somewhat similar solution for the problem in South Africa in that he believes the Florisbad (flake-tool) culture to be older in time than has been hitherto allowed, and that it was the influence of this culture on the Fauresmith that led to the development of the Middle Stone Age; and that it was fertilization by the Florisbad culture that gave rise to the profound changes which took place towards the end of the Fauresmith period. Certainly the natures of the two cultures were entirely different. The coup de poing folk were conservative and uniform in their implement evolution —the development of the industries throughout millennia is the same whether in South Africa, East Africa or Western Europe (= the Chelleo-Acheulean culture). The flake-tool makers were quite different, always experimenting and producing changes and new types of tools. It is difficult to see how the one

culture could have evolved into the other without some such explanation as Prof. Dreyer proposes. But the ultimate origin of the flake-tool folk, whether one is considering those in northern latitudes or their cousins in South Africa, still remains a mystery.

Synthesis of a Pituitary Hormone

THE synthesis of oxytocin, a principal hormone of the posterior pituitary, has been announced by Prof. V. du Vigneaud, professor of biochemistry, Cornell University Medical College, and his colleagues, C. Ressler, J. M. Swan, C. W. Roberts, P. G. Katsoyannis and S. Gordon (*J. Amer. Chem. Soc.*, **75**, 4879; 1953). Oxytocin causes contractions of the uterus, and is also concerned with the 'let-down' of milk from the mammary gland. Previous work had shown that natural oxytocin on hydrolysis yields leucine, *iso*leucine, tyrosine, proline, glutamic acid, aspartic acid, glycine and cystine, and three molecules of ammonia. Based on these results, a synthetic product was obtained by a method described and had the biological properties of natural oxytocin. The authors remark that, if the identity of the synthetic material with oxytocin is confirmed, this will be the first synthesis of a polypeptide hormone.

Japanese Journal of Tuberculosis

MUCH activity is evident in Japan in the field of tuberculosis, and in no less than six universities there are institutes devoted to research in this disease, or in which such study figures prominently. These institutes have now joined in sponsoring a quarterly journal, the *Japanese Journal of Tuberculosis* (pp. 98; November 1953; from the Institute of Infectious Diseases, Shiba-Shirokane-Daimachi, Minato-Ku, Tokyo), under the editorship of Y. Takeda and with a representative editorial board. The first number presents mainly laboratory studies, but also some articles on clinical and epidemiological aspects. It is well produced and is in English. This lusty newcomer to national specialist literature invites comparison with the several British tuberculosis journals, which are showing little success in attracting scientific contributions—particularly those of a laboratory nature—away from their very scattered distribution in other publications.

Photoelectric Scanners for use in Paper Electrophoresis

THERE are numerous descriptions in the literature of instruments for measuring the intensity of the dyed serum protein bands after electrophoresis on paper, which utilize a photoelectric cell for measuring the light transmitted or reflected from a suitable source. By plotting extinctions at given distances along the paper strips, a graph is obtained which provides a quantitative evaluation of the proteins present. Such instruments are now produced commercially. The firm of Evans Electroselenium, Ltd. (Harlow, Essex), provides, in addition to the scanning apparatus, a power unit and specially designed bath for carrying out the initial protein separation. As the scanning apparatus employs transmitted light, the dyed paper strip requires to be wetted with a suitable liquid to render it translucent. A frame carries the translucent strip between two glass plates and has a platform for holding a sheet of graph paper. The whole is moved across the light source, and extinctions read off from a microammeter and plotted on the graph paper. Joyce, Loebl and Co., Ltd. (Vine Lane, Newcastle upon Tyne 1), produces a somewhat more elaborate scanning apparatus (Model 2.*SR*), which incorporates a double-beam amplifier principle and measures reflected light, obviating the need for rendering the paper translucent. It also has a framework for moving the paper across the light source and a platform for holding graph paper; but instead of reading off the extinctions, their values are directly plotted on the graph paper by a pen attached to a slider which is adjusted until the milliammeter reads zero. A feature of both instruments is that readings may be carried out quickly and easily. They are thus suitable for routine clinical investigations. The instruments are also adaptable for measuring the intensity of coloured spots on paper chromatograms.

Determination of the Resolving Power of Photographic Lenses

CIRCULAR 533 of the National Bureau of Standards, Washington, D.C., entitled "Method for Determining the Resolving Power of Photographic Lenses" (pp. iv+27+2 charts. Washington, D.C.: Government Printing Office, 1953; 1 dollar), replaces Circular 428 (1941), and provides the photographer with two sets of improved charts by which the resolving power of a photographic lens may be numerically measured with respect to a definite scale of values. It gives a detailed description of the procedure and technique to be followed in order that comparable values may be obtained by different observers in widely separated laboratories. The average amateur photographer can use the simple objective method described with equipment normally available. One set of charts consists of six high-contrast charts, printed in black ink on a white background, and the other set contains six low-contrast charts, printed in grey ink on a grey background. The range of the charts is 12–80 lines/mm. in contrast with 3·5–56 lines/mm. of the charts in Circular 428. Additional applications to the testing of goggle lenses for definition and prismatic power and of telescopes and binoculars for definition are also discussed in Circular 533.

Hydraulic Research in the United States

INFORMATION compiled from various hydraulic and hydrologic laboratories, and from reports of research projects in private, State or Federal institutions in the United States and in five institutions in Canada, is contained in Miscellaneous Publication 208 of the National Bureau of Standards, entitled "Hydraulic Research in the United States" (pp. xii+204; edited by Helen K. Middleton and Sonya W. Matchett. Washington, D.C.: Government Printing Office, 1953; 1.25 dollars). The projects are numbered chronologically, and the number once assigned is repeated for identification purposes until the project is completed. Numbers above 1544 refer to projects reported for the first time; lower numbers to projects reported earlier in the previous editions (Misc. Publication 201, 1951; Misc. Publication 205, 1952). The information listed gives the title of the project; for whom conducted; the name of the person to whom correspondence should be addressed; the nature of the project (whether experimental, theoretical, etc.); and a brief description of the work, the results so far obtained and any published reports. There is also a comprehensive subject index. In the brief foreword by Dr. A. V. Astin, director of the National Bureau of Standards, Washington,

D.C., it is mentioned that a similar bulletin, "Hydraulic Research", compiled and published by the International Association for Hydraulic Research, contains information on hydraulic research conducted outside the United States, and a companion bulletin, "Directory of Hydromechanics Research Projects in the United States Related to Naval Architecture and Marine Engineering", is prepared by the Hydromechanics Committee of the Society of Naval Architects and Marine Engineers.

Physicists in Britain during July

A list of those taking part in the Eighth General Assembly of the International Union of Pure and Applied Physics, to be held in the rooms of the Royal Society (Burlington House, London, W.1) during July 7–10, has been prepared and is obtainable on application to the assistant secretary of the Royal Society. The numbers of active participants from various countries are as follows: Great Britain, 14; United States, 9; Germany, 7; Canada, 6; France and Italy, 5 each; Spain and Japan, 3 each; Australia, Denmark, Netherlands and Switzerland, 2 each; Belgium, India, Israel and Sweden, 1 each. Since such a comparatively large number of leading foreign physicists will be in Great Britain for the Assembly, a number of other meetings have been arranged around about the same time (see *Nature*, January 30, p. 194), and it is expected that many of the foreign physicists will be attending one or other of these meetings.

Meeting of Nobel Prize-winners in Lindau

As in former years, a meeting of Nobel prize-winners will be held in Lindau, Lake Constance, during June 28–July 2. This year the speakers will discuss various aspects of medicine, which is the second time that this subject will be considered at one of these meetings, the first occasion being at the original meeting in 1951. Ten addresses will be given as follows: Prof. Gerhard Domagk (Wuppertal), Chemotherapie der Tumoren; Prof. Hans von Euler-Chelpin (Stockholm), Faktoren der Blutbildung; Prof. George de Hevesy (Stockholm), Eisenstoffwechsel; Prof. Corn. Heymans (Ghent), über Selbststeuerung des arteriellen Druckes und Hypertension; Dr. Paul Hermann Müller (Basle), Antibiotica, besonders ihre Anwendung im Pflanzenschutz; Prof. T. Reichstein (Basle), die wichtigsten Hormone der Nebennierenrinde; Prof. Frederick Soddy (Oxford), the Wider Aspects of the Discovery of Atomic Disintegration; Prof. George H. Whipple (Rochester, N.Y.), the Dynamic Equilibrium of Body Proteins, Hæmoglobin, Plasma Proteins, Organ and Tissue Proteins; and Prof. Adolf Butenandt (Tübingen) and Prof. Otto Warburg (Berlin), whose topics are not yet decided. Also participating will be Prof. Otto Hahn (Göttingen) and Prof. Albert Schweitzer (Lambaréne-Gabun). The addresses will be of general interest to both medical practitioners and research workers, and opportunities will be provided for discussion. A comprehensive programme of excursions has also been arranged. Further information can be obtained from the Sekretariat der Tagungen für Nobelpreisträger, Lindau-Bodensee, Postfach 11.

Royal Commission for the Exhibition of 1851: Awards for 1954

The Royal Commission for the Exhibition of 1851 has awarded senior studentships for 1954 (value £600 a year for two years) to the following for research as indicated: Miss A. I. Bailey (Witwatersrand), physics at the University of Cambridge; Dr. G. A. Horridge (Cambridge), invertebrate physiology at the University of Cambridge; R. Hicks (Wales), civil engineering at University College, Cardiff; and A. D. Walker (Bristol), vertebrate palæontology at King's College, Newcastle upon Tyne (University of Durham). The Commission has also awarded the following overseas scholarships for 1954 (value £450–£500 for two years). *Canada:* M. J. Fraser (Dalhousie), colloid chemistry at the University of Cambridge; M. Onyszchuk (McGill and Western Ontario), inorganic chemistry at the University of Cambridge; and J. A. Kuehner (Bishops and Queen's University, Kingston), nuclear physics at the University of Liverpool. *Australia:* P. J. Stephenson (Queensland), geology at the Imperial College of Science and Technology, London; and F. W. Eastwood (Sydney), organic chemistry at the University of Oxford. *New Zealand:* G. N. Malcolm (New Zealand), physical chemistry at the University of Manchester. *South Africa:* Dr. S. Papert (Witwatersrand), mathematics at the University of Cambridge. *Republic of Ireland:* Dr. M. F. Maguire (Ireland and Aberdeen), biochemistry at the University of Cambridge. *Republic of India:* K. Aghoramurthy (Madras and Delhi), organic chemistry at the University of Oxford; and S. Chandrasekhar (Nagpur), physics at the University of Cambridge.

National Research Council of Canada Fellowships for Medical Research

Each year the National Research Council of Canada has awarded the following medical fellowships, totalling 76,900 dollars plus travelling allowances, for research at the institutions indicated. *Senior Medical Research Fellowships:* Dr. W. G. B. Casselman, Banting and Best Department of Medical Research, University of Toronto: Dr. C. N. Crowson, Department of Pathology, Queen's University, Kingston, Ontario; Dr. P. C. Fitz-James, Department of Bacteriology and Immunology, University of Western Ontario; Dr. R. W. Gunton, Department of Medicine, University of Toronto, and at the Toronto General Hospital; Dr. F. C. Heagy, biochemistry and bacteriology at the University of Western Ontario; Dr. H. Kalant, pathological chemistry at the University of Toronto; Dr. J. T. Nichol, biophysics at the University of Western Ontario; Dr. J. W. Pearce, physiology at the University of Western Ontario; *Graduate Medical Research Fellows:* Dr. D. E. Bergsagel, blood coagulation at the University of Oxford; Dr. R. W. Cornett, cardiovascular physiology at Queen's University, Kingston, Ontario; Dr. T. E. Cuddy, cardiovascular physiology at the University of Manitoba; Dr. A. Davignon, physiology and biochemistry at Hotel Dieu Hospital, Montreal; Dr. Florence M. Hill, pathology at the University of Toronto; Dr. N. Kalant, endocrinology at the New England Centre Hospital, Boston, Massachusetts; Dr. S. J. Klebanoff, pathological chemistry at the University of Toronto; Dr. Dorothy Ley, iron metabolism in neoplastic disease at Toronto Western Hospital; Dr. A. Malkin, biochemistry at McGill University; Dr. J. C. Nixon, biochemistry at the University of Toronto; Dr. J. E. Nixon, physiological and pharmacological problems related to anæsthesiology at the University of British Columbia; Dr. P. Pollock, cardiology at Mt. Sinai Hospital,

New York City; Dr. Ingeborg C. Radde, endocrinology at the University of Toronto; Dr. R. F. Scott, pathology at the London Postgraduate Medical School, Hammersmith Hospital, London, England; Dr. Joan M. Vale, endocrinology at the University of Toronto.

University of Glasgow

Among those on whom the honorary degree LL.D. was conferred on Commemoration Day at the University of Glasgow, there were two members of the 1914 Shackleton Polar Expedition: Prof. Alexander Stevens, sometime professor of geography in the University of Glasgow, and J. M. Wordie, master of St. John's College, Cambridge, and director of the Scott Polar Research Institute. Other men of science were: Prof. Boris Ephrussi, professor of genetics in the University of Paris, whose ideas and early experiments have strongly influenced the present developments in biochemical genetics; and Sir Edward Salisbury, director of the Royal Botanic Gardens, Kew. Sir Arthur Trueman, sometime professor of geology in the University of Glasgow, and lately chairman of the University Grants Committee, was given the degree *in absentia*.

University of Birmingham

The title of reader in analytical chemistry in the University of Birmingham has been conferred on Dr. R. Belcher, senior lecturer in analytical chemistry, and the title of university research fellow on the following: Prof. D. L. Anderson, associate professor of physics at Oberlin College, Ohio, who will be working in the Department of Physics for a year; and W. D. Seymour, during the tenure of his present appointment in the Department of Engineering Production. The following appointments have been made in the University: Dr. J. D. Eshelby, lecturer in physical metallurgy; Dr. A. B. Foster, Imperial Chemical Industries, Ltd., Fellow in the Department of Chemistry; and F. Edmondson, Leverhulme Fellow in the Department of Engineering Production.

University of Leeds

The following appointments have been made in the University of Leeds: J. B. Butler, senior agricultural economist in the Department of Agriculture; Prof. B. E. Douglas and Prof. H. Taube (Chicago), Brotherton research lecturers in physical chemistry; E. W. Bennett, lecturer in the Department of Civil Engineering. The Department of Bacteriology has received a gift of £700 from Newton Chambers and Co., Ltd., for research.

The Night Sky in July

Full moon occurs on July 16d. 00h. 29m., U.T., and new moon on July 29d. 22h. 20m. The following conjunctions with the moon take place: July 3d. 15h., Venus 5° N.; July 9d. 18h., Saturn 8° N.; July 14d. 00h., Mars 3° S.; July 28d. 08h., Mercury 2° S., and at the same time Jupiter 0° S. In addition to these conjunctions with the moon, Venus is in conjunction with Regulus on July 12d. 08h., Venus 1·1° N., and Mercury is in conjunction with Jupiter on July 28d. 00h., Mercury 1·9° S. Mercury, in inferior conjunction on July 6, is too close to the sun to be seen until near the end of the month; on July 31 it rises at 2h. 50m., nearly an hour before sunrise. Venus is an evening star, its times of setting being 22h. 20m., 22h. 50m. and 21h. 15m. at the beginning, middle and end of the month, respectively. Its stellar magnitude varies between −3·5 and −3·6, and the visible portion of its illuminated disk between 0·76 and 0·66. Mars is visible throughout the night, setting in the early morning hours at 2h. 40m., 1h. 20m. and 0h. 15m. on July 1, 15 and 31, respectively. Its fairly close approach to the moon on July 14 has been already noticed, but observation of the planet will not be then very easy as the moon is only two days from full. During the early portion of July Jupiter is too close to the sun to be seen, but on July 15 it rises at 3h. and on July 31 at 2h. 25m. and is visible for a short time in the constellation Gemini. Saturn sets at 0h. 40m., 23h. 40m. and 22h. 40m. on July 1, 15 and 31, respectively, and is visible during the early morning hours in the constellation Virgo. Only one occultation of stars brighter than magnitude 6 takes place in July: 18 Aquar. reappears on July 17d. 22h. 45·8m., the observation being made at Greenwich. The earth reaches aphelion on July 3.

A partial eclipse of the moon takes place during July 15–16 and is visible at Greenwich. The circumstances of the eclipse are as follows:

Moon enters penumbra	July 15d.	21h.	47·7m.
Moon enters umbra	15	23	09·4
Middle of the eclipse	16	00	20·3
Moon leaves umbra	16	01	31·3
Moon leaves penumbra	16	02	52·9

Magnitude of eclipse is 0·411, the diameter of the moon being 1.

Announcements

The 1954 award of the Commemorative Medal of Prince Albert I of Monaco (Prix Manley-Bendall) has been made to Captain de Corvette G. Houot and Engineer Officer P. Willm, of the French Navy, for their great achievement in descending to a depth of just over 2½ miles off Dakar in the naval bathyscaphe *F.N.R.S.-3*. The award was announced at the meeting of the Executive Committee of the Institut Océanographique held in June at Paris, and the donor of the Medal is generously having it struck in duplicate so that each recipient can possess it.

A Folk Gallery in the Abbey House Museum, Kirkstall, will be opened by Dr. F. Sherwood Taylor, director of the Science Museum, London, on July 2, at 11 a.m. The gallery is in the form of a small street called "Abbey Fold".

The British Institution of Radio Engineers will hold its annual convention at Christ Church, Oxford, during July 8–12; the theme this year will be the application of electronics to industry. Representatives from many branches of industry as well as from the Armed Services, universities and technical colleges will be present. Further information can be obtained from the Institution at 9 Bedford Square, London, W.C.1.

A symposium on "The Comparative Endocrinology of Vertebrates" will be held in the Department of Zoology, University of Liverpool, during July 12–16. The symposium will be in two parts—the comparative physiology of reproduction, and the hormonal control of water and salt-electrolyte metabolism in vertebrates—under the respective chairmanship of Prof. S. Zuckerman and Dr. S. J. Folley. The proceedings of the symposium will be published as a memoir of the Society for Endocrinology. Accommodation is available at the University. All communications should be directed to the organizer, Dr. I. Chester Jones, Department of Zoology, University of Liverpool.

WORLD POPULATION AND RESOURCES

DURING May 5–6 the Executive of the International Geographical Union met in London, and the opportunity was taken to ask three of the vice-presidents to take part in a symposium on world population, under the chairmanship of the Union's president, Prof. L. Dudley Stamp, at the Society for Visiting Scientists.

The discussion was opened by Prof. George B. Cressey (Syracuse University, New York), the immediate past-president of the Union, who outlined briefly the world position which he had elaborated in his presidential address at the Washington conference of 1952 [1]. He used the now generally accepted figures of 2,500 million for the present world population, with a net increase of not less than 25 million per annum. The reality of the situation was vividly brought home by the comment that, by the end of the two hours of discussion, there would be another six thousand mouths to be fed and also another six thousand pairs of hands potentially available for work. Prof. Cressey said that he has been impressed by the extensive abandonment of soil-eroded land over such diverse regions as the United States and China where he has worked and at the same time by the poverty of tropical soils, and he takes the view that the expansion of lands under cultivation will do little more than balance the loss due to erosion. He looks, therefore, for expansion of food output from improved yields of lands already under cultivation. Turning to the position in the United States, where farming efficiency is commonly equated with output per man-hour and not with output per unit area, there is little doubt that agricultural output could be doubled merely by the full application of known techniques. In fact, the doubling of the production between 1900 and 1950 has been achieved by technological advances without any increase in man-power: the spectacular changes in yield which have resulted from the introduction of hybrid maize are indications of possibilities with other crops. The main problem for the future would seem to be an embarrassing surplus, and little likelihood that the prairie monoculturalist will be asked to give up his winter holiday in California in order to secure the greater output from the adoption of mixed farming.

Prof. George Kuriyan (Madras) gave a brief but vivid word picture of the position in the Indian subcontinent, contrasting in almost every conceivable way with the United States. He pointed out that the Union of India had a population of 357 million in 1951 (approximately a seventh of the world's total), compared with 235·5 million over the same area in 1901. During the past three decades (that is, after the great influenza epidemic of 1918–19) the absolute increase in numbers over the whole Indo–Pakistan sub-continent has been approximately 50 million per decade. The British Indian Government, Prof. Kuriyan said, handed on a stable administration after a long period of peace and absence of famine. Improvements in medicine, both preventive and curative, have combined to produce a diminishing death-rate of about 2 per cent per annum against a birth-rate of more than 3.

To compensate this growth, there has been no corresponding increase in the resources, which, as in the past, have remained essentially agricultural. From the beginning of this century, there has been a race between population and resources; but since 1921 population has outstripped resources so significantly that in 1951 the total *per capita* production, taking note of all agricultural output, food and cash crops combined, was approximately 450 lb., while the corresponding figure for 1901 was 600 lb. Furthermore, the pressure upon land has increased so considerably that many parts of the country suffer from over-population, tracts with good agricultural resources having as much as 3,000–4,000 persons per square mile. This, in its wake, has led to the emergence of a class of landless labourers whose total numbers are estimated at 45 millions, a group of people who constitute a vulnerable section in the hands of political propagandists.

The real remedies appear to be, first, to increase the average yield of crops, which to-day is appallingly low; second, to enhance the area under cultivation by improvements in irrigation; third, to find employment for the population in avenues other than agriculture; and fourth, to have a conscious and deliberate check on population growth. The last is certainly the most important; but it is doubtful if it is easily practicable in a country like India, where the standards of education are so low and where religious feelings of the bulk of the population have always looked upon a son as a blessing from Heaven and the more sons the greater the security.

Prof. Hilgard O'Reilly Sternberg (Catholic University of Rio) presented a very different picture from Brazil. The extremely rapid increase in population, now more than 56 million, has been due to only a minor extent to immigration over the past century. Development and close settlement, for so long almost confined to a belt within 100–150 miles of the coast, is now taking place with staggering rapidity in many inland centres. New towns on the pioneer fringe within a few years are finding themselves by-passed as new pioneers move on. It is something like the westward expansion of the United States a century ago but with important differences. Social factors often play a greater part than either physical or economic: there is prestige attached to the ownership of large herds of cattle, and none to the raising of crops of wheat. Consequently, as Prof. Sternberg showed by a series of detailed maps based on the 1950 census, expansion of wheat cultivation coincides mainly with areas of German settlement and not necessarily with the most favoured tracts of land.

The chairman suggested that the three speakers illustrated in a remarkable way that there are at least four levels in the population–food problem. One is the somewhat academic global view; the second the national where, for example, the situations in the United States and India are in marked contrast; in the third place, Brazil illustrates the difference between regions, as well as th[illegible]th stage, which is almost a pin-point [illegible]tionship between an individual farm or settlement and its productive capacity. While the papers showed the

over-riding importance of the physical factors such as climate and soil, economic factors such as farm prices playing an obvious part, the imponderable social factors illustrated by religion and prestige are extraordinarily powerful and persistent.

In the discussion which followed, speakers raised such questions as the increased use of fertilizers and the 'cultivation of the sea'. Three other vice-presidents of the Union were present—Prof. Max Sorre (Paris), Prof. Orlando Ribiero (Lisbon) and Prof. Hans Boesch (Zurich). Prof. Boesch thought the papers emphasized the peculiarly difficult position of the older and more populous countries of Europe relying on their exports to purchase essential foodstuffs from overseas. It is clear, he said, that the great primary producers are not only using more and more of their home production, but are also regarding it as a matter of national prestige to develop their own manufactures. L. Dudley Stamp

[1] *Economic Geog.*, **29**, 1 (1953).

ACOUSTICS OF ORTHOPTERA

A SYMPOSIUM on orthopteran acoustics was held at Jouy-en-Josas, near Paris, during April 5–8 under the auspices of the French Ministry of Agriculture (Institut National de la Recherche Agronomique) and the able management of R.-G. Busnel, director of the Laboratoire de Physiologie Acoustique. It was intended both to be international and to be a meeting-ground for the scientific interests —physical, systematic, physiological, ethological and ecological—which touch each other in this field. In the event, although it is to be regretted that Italy, the Iron Curtain countries and the Americas were unrepresented, it provided the first opportunity since the Second World War for discussion of the subject between French, German and British scientific workers, a discussion much facilitated by comprehensive pre-circulation of individual contributions in two or three of their languages.

There has been little recent work on the physiology of hearing in insects; and apart from a useful survey of this part of the field by H. Autrum (Würzburg), the conference divided its time almost equally between papers on three aspects of the subject: the technique of recording and reproducing the sounds produced by insects; the analysis, oscillographic and spectral, of such sounds with attempts to relate the results, on one hand, to the structure and movements of the insect and, on the other, to the confusing and cumbrous terminology already in use; and the function of such sounds in communication between insects of the same species. Since the complete proceedings will be published shortly in French, it would be unprofitable, even if it were practicable, to abstract each contribution and each discussion here. It seems better to give what to one observer were the salient features of the conference as a whole.

The saltatorial Orthoptera, though not the only insects in which communication by sound has been established, are the best known and have shared with the cicadas the ability to interest and exasperate the human hearer for millennia. But it is only very recently that technical equipment has become available for recording, analysing and synthesizing their songs and so making possible an experimental investigation of their meaning. The pioneer observations of Regen and Faber had already established that different meanings inhered in different varieties of songs; but they had also shown that in certain circumstances a typical response could be obtained to the crudest of imitations while, in others, the insect was not seduced by what appeared to be a perfect copy. This contrast was sharply pointed by two contributions to the symposium. W. Loher (Paris) showed, in an attractive colour-film, how by an imitation made with his own mouth of the 'ordinary song' of *Chorthippus brunneus* (*ci-devant bicolor*), he could attract females of the species on to his person and even on occasion on to his lips. On the other hand, M. and Mme. Busnel described how they had completely failed to obtain a response from the females of *Oecanthus pellucens* by playing back a high-quality record of the song of the male until, with the introduction of a new type of transducer, the ionophone, they began to get positive results. The ionophone, described and demonstrated to the symposium by its inventor, M. S. Klein (Paris), is clearly a technical advance of the first magnitude. It is a completely aperiodic loud-speaker with a flat response up to more than 100 kc./s., and it has a large undistorted power output from what is virtually a point source. It is nevertheless very remarkable that it should be necessary to employ so perfect an instrument in order to make a passable copy of the song of *Oecanthus*, for analysis has confirmed the aural impression that this song is comparatively 'pure', with a fairly simple oscillogram and a relatively narrow spectrum. It is evident that there is still much to be learnt about how the gryllids and tettigoniids detect a spurious copy; and it by no means follows that because some acridiids respond by a tentative approach to an indifferent imitation of the song of their own species, they are unable to distinguish it from the real thing. It is inevitable that comparisons should be made with the experiments of Tinbergen, Lack, Hartley and others, who have shown that a stereotyped reaction can often be elicited from vertebrates by 'models' which correspond only in one or two essential features with the prototype which normally evokes the reaction. Thus small birds which customarily mob tawny owls will mob any dark mottled object of approximately the right size; but they ignore a living barn-owl which is paler, though in other respects it seems to us a much better 'model' of a tawny owl. The determination of what features of the structure of insect songs are 'essential' in this sense to their communicative function is a task for the future, though the investigation is now technically possible. It was interesting and suggestive to find that a comparison of the oscillograms of the 'ordinary song' of *Ch. brunneus* and of Herr Loher's oral imitation disclosed a similarity in structure which was obvious neither to the untutored human ear nor to the spectral analyser.

The majority of vocal saltatoria produce their songs by one or other of two methods which we are accustomed to regard as standard for the group; but D. K. McE. Kevan (Nottingham) gave a substantial list of species employing unorthodox stridulatory devices which he described and which could only be regarded as the result of independent evolution. Unfortunately, little is known of the degree of development of the auditory (tympanal) organs in the heterodox species, or of the importance of stridulation in their life-history; but their existence (many of them are exotic) is a warning not to generalize too widely from the relatively poor orthopteran fauna of Western Europe. B. P. Uvarov

(London) emphasized this danger in pointing out that tympanal organs (ears) are well developed in many dumb acridiids, and that, when the Australian groups are taken into the account, their presence appears to be correlated more closely with the power of flight than with the ability to stridulate. No plausible explanation of this curious paradox has been suggested.

Papers dealing with the sound-field of various types of saltatoria and its relation to their habitat were read by R.-G. Busnel and by P. T. Haskell (London). It is possible to make guesses at the range within which stridulation is an effective means of communication and to account plausibly for some of the characteristic differences of the stridulation patterns of acridiids and tettigoniids in terms of their different habitats, the former insects being relatively densely distributed at ground-level while the latter are scattered in three dimensions. Nevertheless, both these papers made clear the need for better determinations of the auditory threshold in a larger number of species than have yet been attempted. Moreover, as Autrum emphasized in his introductory survey, the division of the auditory function between tympanal organs, sub-genual organs and cerci is a complication of which the consequences are not understood and have scarcely begun to be investigated. One can only agree with the observations of Prof. P. P. Grassé in the address with which he brought the conference to an end: "On ne peut dire que les études faites jusqu'ici sur les sons en tant que facteurs de la structure sociale ou du simple maintien du groupe soient satisfaisantes. . . . Un des mérites du present Colloque sera d'avoir bien montré la necessité d'établir les veritables nature et signification des réactions aux stimulations sonores". It must be admitted that this symposium represented seed-time rather than harvest; but it has performed a service of value in stimulating a reorientation of ideas and in indicating lines of research which are likely to be profitable, which are now technically possible, and which, moreover, are certainly relevant to a much wider field than its deliberately restricted agenda might suggest.

R. J. Pumphrey

SMITHSONIAN INSTITUTION

REPORT FOR THE YEAR 1952–53

THE report of the Secretary of the Smithsonian Institution for the year ended June 30, 1953, to which are appended the usual reports on the United States National Museum, the Bureau of American Ethnology, the International Exchange Service, the National Zoological Park, the Astrophysical Observatory, the National Air Museum and the Canal Zone Biological Area*, points out that almost all the endowments were given for specific purposes and little of the income from the invested funds of the Institution is available for alteration or growth from year to year. Generally, the continuing activities of the Smithsonian Institution have financially remained static during the past twenty years or have even retrogressed. While the national collections in the care of the Smithsonian have increased by 130 per cent since 1934, the number of visitors to its five exhibition buildings has increased by 150 per cent, and the correspondence on scientific and other questions multiplied several times, the man-hours per week available at the Institution have decreased and the appropriation for functions other than staff is 11,000 dollars less than in 1933. Appropriations for the fiscal year 1954 will, however, permit first steps towards the overdue rehabilitation of its exhibitions and the renovation of some of its buildings, though funds for continued modernization and renovation will be urgently required in succeeding years as well as plans for new buildings.

At the end of 1952 the activities of the Institute of Social Anthropology were terminated, and anthropologists remaining on its staff were transferred to the Institute of Inter-American Affairs. Systematic researches of the anthropologists of the Bureau of American Ethnology included Dr. M. W. Stirling's archæological work in Darien and on the islands of the Gulf of Panama, Dr. H. B. Collins's studies on the Eskimo and arctic anthropology, Dr. J. P. Harrington's studies of the Chumash Indians of the Santa Barbara Channel region, California, and those of Dr. P. Drucker of Meso-American archæology. In the investigations of the River Basin Surveys carried out by the Bureau in co-operation with the National Park Service and the Bureau of Reclamation of the Department of the Interior, the Corps of Engineers of the Army Department and various State and local institutions, greater emphasis continued to be laid on excavation now that survey has largely caught up with the general programme. Of the 3,469 archæological sites located and recorded by the survey parties, 852 have been recommended for excavation or limited testing. Already 172 preliminary appraisal reports have been distributed, and excavations made in 42 reservoir projects located in 17 States. Palæontological surveys have been made in 121 reservoir areas, and archæological work has also been done in 88, while the remaining 33 will be visited by archæological parties. Already 273 reservoir basins, including those where archæological studies are still to be made, have been surveyed.

The collections of the National Museum increased by more than 1,607,000 specimens during the year, bringing the catalogue entries to nearly 35 million. Exploration and field-work during the year included C. O. Handley's observations and collections of mammals in the Kalahari desert region of north-eastern South West Africa, Dr. A. Wetmore's studies on the distribution of bird life in Panama, H. G. Deigman's ornithological work in Thailand, studies of coral-atoll ecology in Tahiti and on Raroia Atoll, and searches for invertebrate and vertebrate fossils by three parties at Adair, Oklahoma, in the Guadalupe Mountains of western Texas, in north, east and south Mexico and in south-central Wyoming. Accessions to the National Zoological Park numbered 810, bringing the net count of animals at the end of the year to 2,741, but there was a slight decrease in the number of visitors, who totalled about 3,231,000.

At the Astrophysical Observatory the manuscript of Vol. 7 of the *Annals* of the Observatory, covering its research during 1939–52, was completed and sent to press late in the year. A thorough study of the silver-disk pyroheliometer was completed in April 1953. Tape exposures to total sun and sky radiation continued at Montezuma, Chile, where a new modern seismometer is now being installed, and at Table Mountain, California, the permanence of the con-

* Smithsonian Institution. Report of the Secretary and the Financial Report of the Executive Committee of the Board of Regents, for the Year ended June 30, 1953. (Smithsonian Publication 4141.) Pp. x + 168 + 6 plates. (Washington, D.C.: Government Printing Office, 1953.)

stants of the Smithsonian double-tube, water-flow standard pyroheliometer and of the sub-standard silver disk pyroheliometer *S.I.5* has been confirmed. The researches of the Division of Radiation and Organisms continue to be concerned chiefly with the physiological and biochemical processes by which light regulates the growth of plants and the mechanisms of the action of the auxin type of growth hormone. Investigations of the effect of plant-growth regulators on the salt exchange of plants indicated that high salt – low carbohydrate plants lose salt more rapidly when treated with ammonium 2 : 4-dichlorophenoxyacetate, while low salt – high carbohydrate plants absorb salt less rapidly compared with untreated plants.

Of the seven hundred visitors to the Canal Zone Biological Area, fifty-seven were scientific workers who used the facilities of the station, considerably improved during the year, chiefly for biological and photographic studies. The 1,021,938 packages of government scientific and literary publications handled by the International Exchange Service during the year, an increase of 20,324 packages, included consignments to all countries except China, North Korea and Rumania. A grant of 6,000 dollars towards rising transport costs was received from the National Science Foundation. The Service now dispatches abroad sixty-three full and forty-two partial sets of United States official publications in exchange for the official publications of other Governments.

WOOL INDUSTRIES RESEARCH ASSOCIATION

REPORT FOR THE YEAR 1953–54

THE report of the Director of Research of the Wool Industries Research Association for 1953–54* expresses the view that the statutory levy for research, which has now been in operation for two years, has both increased the interest of members and also enabled the Wool Textile Research Council to clarify the relation of research at the universities and technical colleges to that of the Association. The pilot-scale scouring plant was completed towards the end of the year and has given results well up to commercial standard. Data have been obtained on the possibility of alkali damage to wool during commercial scouring. A prototype of the automatic controller for the woollen card designed in the Association's laboratories some years ago is undergoing trials in a mill and seems to be suitable for commercial use; and a second controller, which may be particularly suitable for cards with ball and bank feeds, is also under trial. Commercial development of the Raper drawing system, incorporating autolevellers, has now been taken up, and a most encouraging number of firm orders has been placed by British spinners; a great deal of the early work on this new system was done in the Association's laboratories. Much new information about the drafting process has been obtained by the use of radioactive tracers, and considerable progress has also been made in an attempt to understand theoretically how tensions are generated in yarns being drawn from packages, and how this tension should vary with the dimensions of the package and the position of the twizzle through which the yarn must pass.

In chemical technology 449 investigations were carried out on behalf of member firms. Scouring experiments continued, and a large-scale trial demonstrated that bulk removal of cellulose acetate fibre from rags is technically feasible. The practicability of dyeing wool at high temperatures without undue damage to fibres has been confirmed, provided the *p*H of the dye liquor and the time of treatment are kept within limits. Experience has shown that the Association's fineness meter, based on the air-flow method, is quick and reliable and that the accuracy in the mean fibre diameter of tops is at least as high as that obtained with a projection microscope. A rapid method of comparing the strength of two yarns has been devised, which can be used where no strength machine is available. Work in the Biology Department on Scots blackface, Herdwick and Suffolk breeds of sheep has emphasized the importance of the secondary to primary follicle ratio in the development of fine wools, and the effect of breeding and of nutrition on this ratio is being studied.

The use of starch columns together with fraction cutters for quantitative estimation of amino-acids by colorimetric and radioactive methods continued, and by the method of hydrazinolysis the carboxy terminal end-groups of wool have been found to be serine, glycerine, threonine and alanine. A study of the effect of dry chlorination on dyed nylon has been completed. Experiments with textiles and ion-exchange resins have shown the electrolytic nature of charge separation by contact between dissimilar polar polymers, the sign of the charge being determined by the excess of freely diffusible ions in the polymer. Complete X-ray data have been obtained for the hydrochloride and hydrobromide of glycyl-L-alanine, and a Fourier projection has been determined which gives an accurate picture of the atomic arrangement.

* Wool Industries Research Association. Publication No. 199 : Report of the Director of Research for 1953–54. Pp. 32. (Leeds : Wool Industries Research Association, 1954.)

ROYAL SOCIETY DEPOSITORY OF UNPUBLISHED MATHEMATICAL TABLES

THE following is a list of accessions to the Royal Society's depository of unpublished mathematical tables since the publication of the last list in *Nature* (**171**, 1140; 1953):

(22) Factorisation des nombres $2N^4 + 1$, $N \leqslant 1000$ (A. Gloden);

(23) Factorization of $N = 3n^4 - 1$, $0 < N \leqslant 1000$ (A. Ferrier);

(24) High-accuracy square- and cube-roots (D. F. Ferguson, C. E. Gwyther and J. C. P. Miller);

(25) A solution of the equation $(y'')^2 = yy'$;

(26) Table of

$$F(\beta,\rho) = \frac{2}{\sqrt{\pi}} \frac{\exp(-\rho^2)}{\beta^2} \int_0^\beta I_0(2\rho\eta) \exp(-\eta^2)\, \eta\, d\eta;$$

(27) Tables of $F(x) = 2x \sum_{n=0}^{\infty} \{x^2 + (2n+1)^2\}^{-3/2}$ and of $x^{-1}F(x)$;

(28) Table of $G(x) = 6x^3 \sum_{n=0}^{\infty} \{x^2 + (2n+1)^2\}^{-5/2}$;

(29) Tables of

$$f(x) = \sum_{n=0}^{\infty} (-)^n (2n+1)\{x^2 + (2n+1)^2\}^{-5/2}$$

and of $x\,f(x)$;

(30) Table of

$$f(x,y) = \frac{1}{2\pi}\int_0^{2\pi} \exp(-x\cos\theta - y\cos^2\theta)\,d\theta;$$

(31) Tables associated with $\int_0^{\theta} (\cot u + \mu \sin u)^{-1}\,du$;

(32) Tables of $\int_0^x \exp(-2\pi i r)dt$

and $\int_0^x r^{-1} \exp(-2\pi i r)dt$, where $r^2 = a^2 + t^2$;

(33) Tables of integrals associated with the zeros of $\tan z + \tanh z$;

(34) Values and contours of

$$\int_0^{\infty} [\exp(-k)\{J_0(kx)\cosh(ky) - 1\}/\sinh k]\,dk;$$

(35) Table of

$$f(x) = \exp(-x)\int_0^{\pi/2} \exp(x\cos\theta)\sin^2\theta d\theta)$$

(36) Zeros of the first ten Laguerre polynomials and the corresponding Christoffel numbers;

(37) Tables of $\int_0^{\infty} \exp\{-k^{-1/2}u + i(2tu - u^2)\}\,du$ for $k = \frac{1}{4}, \frac{1}{2}, 1, 2, 4$ and 8;

(38) Tables for the summation of trigonometrical series;

(39) Tables of the incomplete Airy integral;

(40) Tables of the functions associated with the Airy integral for complex arguments;

(41) Tables of the function $C(m,\mu;\ x)$.

Tables 25–29 were compiled by the Admiralty Research Laboratory; Tables 30–41 by the Admiralty Computing Service.

Further information about these tables may be obtained on application to the Assistant Secretary, The Royal Society, Burlington House, London, W.1.

THE A.D.E. PHOTO-ELECTRIC INTEGRATOR

By J. R. LOWE

Fort Halstead, Nr. Sevenoaks, Kent

THE instrument described in this article is capable of evaluating surface integrals of any function over a domain with any (possibly irregular) boundaries not containing poles of the function. It is necessary to prepare suitable photo-plate representations of the function, together with opaque masks representing the domain of integration: these preparations will be merited in cases such as the survey task with which we were concerned, which entailed the evaluation of very many surface integrals within irregular boundaries. The accuracy obtainable with the instrument is not yet precisely known, as it is still in the development stage, but the order of errors encountered at present is mentioned later.

In essence, the instrument consists of a light-diffusing table, illuminated from beneath, above which a photo-plate grating and a photo-electric cell are arranged. The grating represents the function to be integrated, and an opaque mask placed on the illuminated table represents the domain of integration. The photo-electric cell current, which depends upon the incident light energy, can, by suitable calibration, be interpreted as a surface integral. The relationship between the (non-uniform) light distribution on the table and the height and characteristics of the cell is such that, in the absence of the grating, an opaque mask of given area on the table screens the cell from a fixed quantity of light, independent of the position of the mask on the table. Thus without the grating the instrument would function as a planimeter.

In the instrument which is now in use at Fort Halstead, the light-diffusing table is illuminated from beneath by twenty lamps arranged in a ring: the lamps are fed by alternating current and have a 20 per cent modulation. Two types of photo-plate grating, representing the function to be integrated, have been used with equal success, namely, high-contrast and silver deposit on glass plates, both of full-plate size ($8\frac{1}{2}$ in. $\times$ $6\frac{1}{2}$ in.). The light transmitted through any small element of area on the grating is proportional to the value assumed in a corresponding element by the function represented. The plates used (see Fig. 1) have discrete patterning small enough to give sensibly continuous representation of the (continuous) function over the domain of integration. The photo-electric cell is a cæsium vacuum cell with a 1-in. diameter light-diffusing 'eye' at a fixed height above the table. The cell current follows the lamp emission, consisting of a constant component plus a ripple. This current is passed to a unit in which the constant component is blocked by a condenser prior to injection into the grid circuit of the first valve. This governs the valve current, which therefore follows the lamp emission and which passes through a sensitivity control to further amplification, rectification and a galvanometer. There is a maximum amplification of 20,000 from cell current to galvanometer current. Thus the galvanometer readings, which are interpreted as surface integrals, are

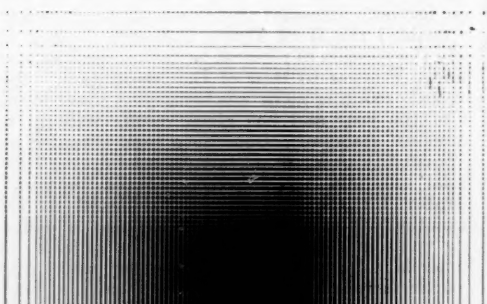


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Fig. 1

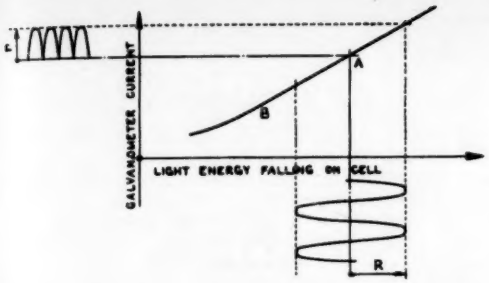

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Fig. 2

responsive only to ripple; hence, under normal working conditions, slow variation of ambient light can be tolerated. By normal working conditions we imply that the obscuration of the cell, due to the grating-mask combination, is not too great.

This proviso will be understood from Fig. 2, which depicts the instrument characteristic at the low-illumination end of the curve. In this region there is a departure from linearity due mainly to the combined effects of the cell and rectifier characteristics. The constant component of illumination fixes the operating point A, while the ripple of amplitude R is followed by the rectified current of amplitude r. Hence, provided that A remains on the straight part of AB, which has constant slope, the galvanometer response is a true image of the ripple. If, however, the steady illumination is weak enough (that is, the obscuration great enough), then the operating point will move to B and the galvanometer response will be distorted. We can, of course, calibrate for any operating point, but only when this lies in a region of constant slope can (slow) variations of ambient light be tolerated; in practice, where obscuration is great, additional steady illumination between grating and cell is provided to keep the operating point up.

The instrument has been used successfully to give integrals of a bivariate normal distribution function over a domain with irregular boundaries. The initial work consists of (i) the preparation of the gratings and masks, (ii) the matching of these to the conditions of the problem, that is, the initial instrument settings, and (iii) calibration of the instrument. These tasks complete, the evaluation of the surface integrals proceeds very rapidly and entails merely placing the masks in position and reading the galvanometer. Calibration is very simple; one merely brings the galvanometer to zero, with a clear table obscures known proportions of the probability distribution and observes the corresponding galvanometer readings.

The present method of preparing the gratings is to draw diagrams, to a large scale, consisting of alternate bands of black and white to represent a univariate normal distribution. Photographic superposition of two such diagrams, to a reduced scale and with their bands perpendicular, then gives the required grating. Thus, consider a plain white sheet divided into narrow vertical strips each of width $L + D$. We locate the mean of the normal distribution at the central strip and we wish to blacken a band in each strip (for example, that distant x from the mean measured perpendicular to the strips) such that the remaining white band-width, L, is proportional to the value assumed by the normal distribution (at distance x from the mean). That is to say, we require:

$$\frac{L}{L+D} = K \exp\left(\frac{-x^2}{2\sigma_1^2}\right).$$

If, for simplicity, we choose zero blackening at the mean, that is, we choose $D = 0$ when $x = 0$, then we have:

$$\frac{L}{L+D} = \exp\left(-\frac{x^2}{2\sigma_1^2}\right).$$

Likewise, for the second diagram we have:

$$\frac{L'}{L'+D'} = \exp\left(-\frac{y^2}{2\sigma_2^2}\right).$$

If $L + D = L' + D'$, then the strips in the above diagrams when superimposed define a system of small squares. Consider the square located at (x, y): the proportion of white surface in this square is clearly

$$\frac{L}{L+D} \times \frac{L'}{L'+D'} = \exp\left(-\frac{x^2}{2\sigma_1^2} - \frac{y^2}{2\sigma_2^2}\right).$$

Thus, when a photo-plate grating is prepared from these diagrams, the light energy arriving at the photo-electric cell, via the unblackened areas of the grating, is governed by the binormal distribution function. Fig. 1 depicts a negative of a binormal distribution grating for which $\sigma_1 = \sigma_2$.

The accuracy obtained with the instrument in recent work is shown by the following results. Using square masks to denote the domain of integration, a series of integral values were obtained of magnitude 0 to 1 (they were probabilities). These values were compared with correct values calculated from error function tables, and the standard deviation of the discrepancies was 0·002. A more adequate (and much longer) statement about accuracy could be made, but this would not be reasonable as our work to date has been of a preliminary nature only.

Acknowledgment is due to Mr. L. Z. Solomides, of the Research and Development Department of Londex, Ltd., Anerley, London, S.E.20, for the successful development of this instrument; also to the Chief Scientist, Ministry of Supply, for permission to publish this article.

EFFECT OF NUCLEIC ACIDS ON PROTEIN SYNTHESIS AND AMINO-ACID INCORPORATION IN DISRUPTED STAPHYLOCOCCAL CELLS

By Dr. E. F. GALE, F.R.S., and JOAN P. FOLKES

Medical Research Council Unit for Chemical Microbiology, Department of Biochemistry, University of Cambridge

IT has frequently been suggested in recent literature that nucleic acids have an organizing or controlling role in protein synthesis. These suggestions arise from consideration of three main types of experimental evidence: that the rate of growth or of protein synthesis in a variety of cells can be correlated with the nucleic acid content of those cells[1]; that changes in the activity or composition of bacterial cells as a result of the action of transforming factors or bacteriophages are associated with addition

of deoxyribonucleic acid to the cells[2]; and that no convincing demonstration of protein synthesis has been obtained under physiological conditions by proteolytic enzymes. The further suggestion has been made that nucleic acids act as templates accomplishing the organization of amino-acid residues within protein structures[3,4]. But any proof of the part they play, let alone its mechanism, awaits the preparation of an experimental system which can synthesize protein and on which an effect of nucleic acids can be demonstrated. Such a system has now been obtained by disruption of suspensions of *Staphylococcus aureus* by exposure to supersonic vibration.

Preparation of Disrupted Cell Material

Staphylococci are harvested while in the stage of active growth after 13 hr. incubation at 30°, washed once in water and made into thick suspension (40 mgm. dry weight of cells/ml.) in 10 per cent sucrose solution buffered with 0·03 *M* phosphate buffer at *p*H 6·5. The suspension is then subjected to supersonic vibration of 25 kc./sec. generated by a 500-W. Mullard magnetostrictor oscillator, the transducer-cup assembly being cooled in ice throughout the exposure. The time of exposure varies with the type and efficiency of the assembly used; in a typical case, exposure for 10–15 min. at full power reduced the viable count to 0·1 per cent of the original, while complete disintegration of the cells took place in approximately 35 min. If the material obtained after 20–25 min. exposure in such an assembly is centrifuged at 800 *g* for 7 min., any unbroken cells are removed; the supernatant is turbid and the greater part of the sedimentable material responsible for this turbidity can be centrifuged down in 20 min. at 4,000 *g*. The sediment so obtained, after one washing in phosphate buffer at *p*H 6·5, provides the disrupted cell material used for these studies and, on a dry weight basis, represents approximately 3 per cent of the original cell suspension. Electron microscope examination of the sediment shows that it consists of broken cell envelopes each containing a small round mass of electron-dense material in the centre. Chemical analysis shows that the 'cells' have lost approximately half their protein and nucleic acid at this stage. They are non-viable and have no respiration; they are, however, able to form acid from glucose and to use adenosine triphosphate in the presence of hexosediphosphate as energy source for amino-acid incorporation or protein synthesis processes[5].

Nucleic acid can be removed from these 'cells' by extraction with *M* sodium chloride or incubation with ribonuclease or deoxyribonuclease. The usual procedure adopted for such resolution has been to incubate the preparation in *M* sodium chloride for 1 hr. at 37°; this treatment removes approximately 30 and 55 per cent of the remaining protein and nucleic acid, respectively. Incubation with ribo- or deoxyribo-nuclease (100 μgm./ml.) for 1 hr. at 37° removes approximately 75 per cent of the remaining nucleic acid. Electron microscope examination of the disrupted cell material after such treatment shows that the electron-dense material has largely disappeared and that the majority of the 'cells' consist of cell envelopes with only traces of electron-dense substance in their centres. The amount of nucleic acid that can be removed from the preparation increases with the time of exposure to supersonic vibration; material obtained after 30 min. exposure can be rendered almost free from nucleic acid in this way.

Incorporation of ^{14}C-labelled Glutamic Acid

If the disrupted cell material is incubated with ^{14}C-labelled glutamic acid, adenosine triphosphate and hexosediphosphate, labelled glutamic acid becomes incorporated into the protein fraction of the 'cells'[5]. In the absence of other amino-acids, this incorporation ceases after 90–120 min. incubation (see Fig. 1) and the incorporated radioactive glutamic acid can be partially removed by subsequent incubation of the preparation with adenosine triphosphate, hexosediphosphate and unlabelled glutamic acid[5]. It appears that this incorporation takes place as a result of an exchange reaction between glutamic acid residues of the protein and glutamic acid (possibly after activation by adenosine triphosphate) in the medium[5,6]; the process is not accompanied by any measurable synthesis of protein. It can be calculated that, under optimal conditions, some 5–6 per cent of the total protein glutamate residues undergo such exchange reactions. Staphylococci cannot synthesize protein unless a wide variety of amino-acids is provided in the incubation mixture[4]; if a complete mixture of the naturally occurring amino-acids is added to the incubation mixture, incorporation of ^{14}C-labelled glutamic acid by disrupted cells continues in a linear fashion for some hours (as shown in Fig. 1) and is accompanied by a small but parallel increase in the protein–nitrogen content of the preparation[7].

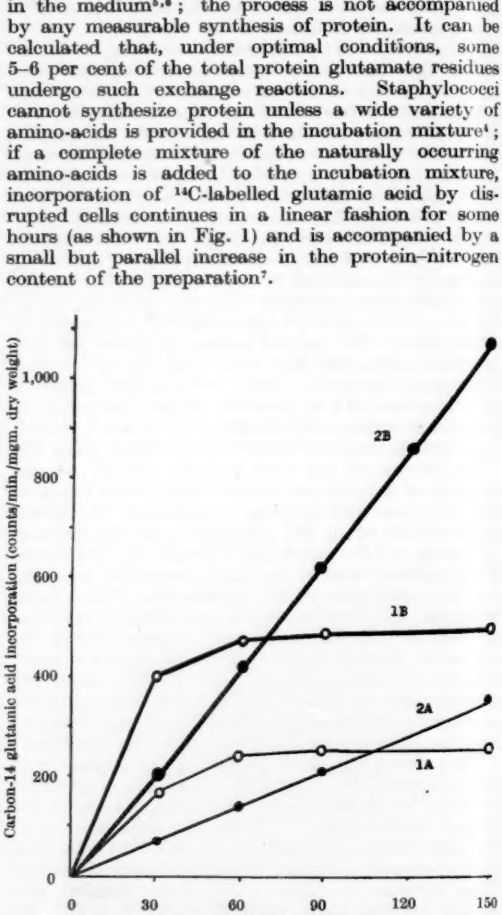

Fig. 1. Course of incorporation of ^{14}C-labelled glutamic acid by disrupted cell preparation
Curve 1*A*: preparation incubated with adenosine triphosphate, hexosediphosphate and α-carboxy-^{14}C-glutamic acid. Curve 1*B*: as for 1*A* with addition of 0·1 mgm. staphylococcal nucleic acid/ml. Curve 2*A*: as for 1*A* with addition of complete mixture of amino-acids. Curve 2*B*: as for 1*B* with addition of complete mixture of amino-acids. Counts carried out on protein fraction of preparation in all cases

If nucleic acid is removed from the disrupted cells by any of the methods mentioned above, the ability of those cells to incorporate glutamic acid, whether in the presence or absence of an amino-acid mixture, decreases markedly, and this ability is restored by addition of nucleic acid prepared from the soluble portion of the supersonic disintegrate by the method of Jones[8]. The staphylococcal nucleic acid has been separated into deoxyribo- and ribo-nucleic acid fractions by the method of Dutta, Jones and Stacey[9] and the fractions cleaned up by treatment with the appropriate nuclease (deoxyribonucleic acid fraction treated with ribonuclease), followed by precipitation of the sodium salts with ethanol, solution in water and dialysis against distilled water. The incorporation of ^{14}C-glutamic acid under exchange conditions is markedly accelerated by addition of either ribo- or deoxyribo-nucleic acid[10], a system containing 1·0 mgm. dry weight of disrupted cells/ml. being completely activated by 0·08 mgm. ribo- or 0·04 mgm. deoxyribo-nucleic acid/ml.

Exchange reactions are not confined to glutamic acid but take place to varying extents with all amino-acids tested[4]. However, when the effect of resolution and reactivation by nucleic acids was investigated, it was found that the results varied greatly with the amino-acid tested. For example, ribonucleic acid activation of a salt-resolved preparation towards incorporation of glycine, aspartic acid, glutamic acid or alanine, each tested alone, was found to be 550, 210, 150 and 0 per cent, respectively. No procedure yet adopted has resulted in a demonstrable effect of nucleic acid on incorporation of alanine. Fig. 1 shows the progress of incorporation of ^{14}C-glutamic acid in a salt-resolved preparation with (curves marked *B*) and without added nucleic acid (curves marked *A*) when incubation takes place either with glutamic acid as the only amino-acid present (condition for curves marked 1) or with a complete mixture of amino-acids including ^{14}C-glutamic acid (curves marked 2).

Whether the amino-acid mixture is present or not, addition of nucleic acid has a marked effect on the incorporation, and it seemed possible that the effect shown in curves 2*A* and 2*B* might represent an action of nucleic acid on synthesis of protein in the disrupted cell preparation. If this were the case, similar results should be obtained under the conditions of curves 2*A* and 2*B*, whichever of the amino-acids in the mixture were labelled with carbon-14. Accordingly, an experiment was carried out under these conditions with either glycine or aspartic acid or glutamic acid or alanine labelled in parallel samples; it was found that the effect of nucleic acid again varied with the amino-acid the incorporation of which was being measured; thus the incorporation of glycine under conditions shown by curve 2*B* took place, in one experiment, at a rate 120 per cent greater than that under conditions of curve 2*A*, while parallel measurements of the incorporation of alanine showed no effect due to the addition of nucleic acid. It is clear that such studies of the incorporation of labelled amino-acids cannot be used as a means of studying the action of nucleic acids on protein synthesis as such. This confirms the similar conclusion previously drawn from studies of the incorporation of labelled amino-acids in intact staphylococci[4,11].

Synthesis of Protein and Specific Enzymes

After the results described above were obtained, it was decided to abandon the isotope method for studying protein synthesis and to investigate, instead, changes in protein-nitrogen and in certain enzymes found to be active in the preparations used. The enzyme systems so far investigated (see Fig. 2) are catalase[12], enzymes involved in the formation of acid from glucose[13], and the adaptive enzyme, β-galactosidase[14]. The disrupted cell preparations used were obtained by exposing staphylococci as described above to supersonic disintegration for 25–30 min. and then resolving the active fraction by extraction with *M* sodium chloride. The preparation was incubated at a final suspension density of 0·3–1·0 mgm. dry weight/3·5 ml. in a salt solution buffered at *p*H 6·2 containing 2 μmoles adenosine triphosphate/ml., 18 μmoles hexosediphosphate/ml. and a complete mixture of amino-acids[1c] with each component at a final concentration of 0·5 mgm./ml. To various samples, suitable amounts of deoxyribonucleic acid, ribonucleic acid or a mixture of purines and pyrimidines[1c] were added; the concentrations of nucleic acids giving optimal responses varied from experiment to experiment between the limits of 0·02 and 0·1 mgm./ml., and experiments were usually conducted over this range of each nucleic acid; the purine–pyrimidine mixture was added at a final concentration of 25 μgm. of each component/ml. Incubation was carried out at 37° in centrifuge tubes for 1–2 hr., and the disrupted cells then centrifuged down for analysis and enzyme determinations.

Clearest results were obtained with preparations from which nearly all nucleic acid had been removed; in such preparations it has been possible to show a significant development of the three activities investigated and to demonstrate effects of nucleic acid on such development. In some preparations the rate of production of acid from glucose was negligible; but this activity could be developed by incubation in the presence of amino-acids and either nucleic acid or the purine–pyrimidine mixture, amino-acids alone having little effect (see Fig. 2). The catalase activity could be doubled by incubation for 90 min. under appropriate conditions while, since the original cells had been grown in the absence of lactose or galactose, the preparation was initially devoid of β-galactosidase activity. Conditions leading to the development of the three activities are summarized in Fig. 2; in all cases appropriate controls have been carried out, though not shown in Fig. 2, and the development was abolished either if the amino-acid mixture were omitted or if 30 μgm. chloramphenicol (which inhibits protein synthesis[1c])/ml. were added to the incubation mixture. Consequently, it is a reasonable assumption that the activities develop as the result of protein synthesis. Increases in protein–nitrogen of the preparation are not as marked as the increases obtained for some enzymes, probably because the preparation contains non-functional protein in the cell-wall, etc. Incubation for 90 min. with amino-acid mixture alone and in the presence of deoxyribo- or ribo-nucleic acid, or purine–pyrimidine mixture, gave rise respectively to 2, 21, 31 and 20 per cent increase in protein–nitrogen.

The development of the enzyme system producing acid from glucose is markedly stimulated by the presence of the purine–pyrimidine mixture and somewhat less stimulated by the presence of either deoxyribo- or ribo-nucleic acids; the addition of either of the nucleic acids together with the purine–pyrimidine mixture gives less stimulation than the latter alone. This is a complex enzyme system, and

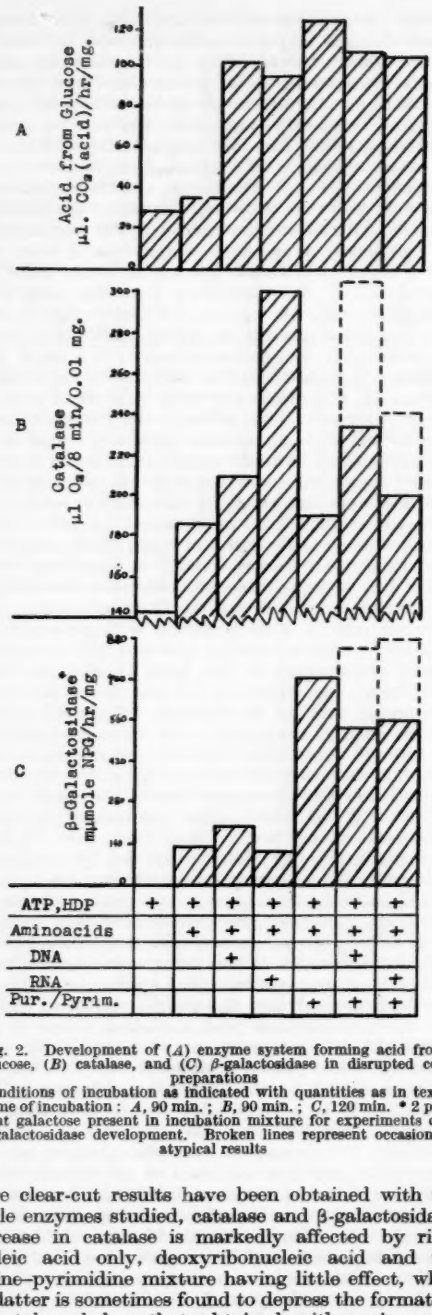

Fig. 2. Development of (*A*) enzyme system forming acid from glucose, (*B*) catalase, and (*C*) β-galactosidase in disrupted cell preparations

Conditions of incubation as indicated with quantities as in text. Time of incubation : *A*, 90 min. ; *B*, 90 min. ; *C*, 120 min. * 2 per cent galactose present in incubation mixture for experiments on β-galactosidase development. Broken lines represent occasional atypical results

more clear-cut results have been obtained with the single enzymes studied, catalase and β-galactosidase. Increase in catalase is markedly affected by ribonucleic acid only, deoxyribonucleic acid and the purine–pyrimidine mixture having little effect, while the latter is sometimes found to depress the formation of catalase below that obtained with amino-acids alone. The addition of the purine–pyrimidine mixture to ribonucleic acid decreases the effect of the acid; in some cases the mixture accelerates the effect of deoxyribonucleic acid alone, and on one occasion (as shown in Fig. 2) the two together gave a slightly greater stimulation than ribonucleic acid alone.

The development of the adaptive β-galactosidase system is particularly interesting. In no case has it been possible to develop this activity in the absence of a suitable inducer such as galactose. In the presence of galactose, amino-acid mixture and the purine–pyrimidine mixture, there is a rapid formation of β-galactosidase in the preparation and the development continues in a linear fashion for up to 3 hr. In 'cell' preparations which are only partially resolved, the presence of amino-acid mixture gives rise to formation of enzyme at a rate 30–45 per cent of that obtained by the further addition of the purine–pyrimidine mixture. With 'cells' at this stage, neither ribo- nor deoxyribo-nucleic acid has any significant stimulating effect although, on three occasions out of twelve tests, a high concentration (0·3 mgm./ml.) of ribonucleic acid obtained from organisms grown in galactose has increased the effect of the purine–pyrimidine mixture although it has had no action in the absence of the latter. In highly resolved preparations, the enzyme formation due to amino-acids alone is small, while the response to the purine–pyrimidine mixture also decreases and can be abolished by treatment of the preparation with deoxyribonuclease. Addition of 0·015 mgm. deoxyribonucleic acid/ml. now significantly stimulates enzyme formation in the presence of amino-acids and restores the response to the purine–pyrimidine mixture to normal ; deoxyribonucleic acid extracted from cells grown in galactose has proved two–three times more active than deoxyribonucleic acid extracted from cells grown in glucose. The presence of ribonuclease in such cases abolishes the response to both deoxyribonucleic acid and the purine–pyrimidine mixture.

Incubation of intact staphylococci with glucose, amino-acid mixture and the purine–pyrimidine mixture gives rise to nucleic acid synthesis within the cells, the presence of the amino-acid mixture being an essential part of the system[16]. The effect of the purine–pyrimidine mixture on the development of certain enzymes in disrupted cell preparations suggests that these preparations may also be able to synthesize nucleic acid under the conditions used. This has been tested by adding ^{14}C-labelled uracil or thymine to the purine–pyrimidine mixture and determining the incorporation of radioactivity into the nucleic acid of the preparation. No incorporation of thymine was found in any of the conditions tested. When disrupted cells were incubated with ^{14}C-uracil, adenosine triphosphate, hexosediphosphate and either the purine–pyrimidine mixture or amino-acids separately, incorporation was insignificant ; when the purine–pyrimidine mixture and amino-acids were present together, incorporation took place at a rate corresponding to approximately 3 mµmoles uracil/hr./mgm. dry weight of preparation ; when galactose was added (as for the development of β-galactosidase) in the presence of amino-acids and the purine–pyrimidine mixture, the rate of uracil incorporation increased five–six times. It appears that the disrupted cells can synthesize ribonucleic acid from the purine–pyrimidine mixture and other components of the medium under suitable conditions.

Action of Penicillin on Enzyme Formation

Table 1 shows the effect of the addition of penicillin to the incubation mixture during the development of the various enzyme systems studied. The development of catalase or the acid-producing system from glucose is insensitive to penicillin unless the concentration of the antibiotic is taken to very

Table 1. Effect of Penicillin on Development of Enzyme Activities in Disrupted Cell Preparation

Penicillin concentration (int. unit/ml.)	Per cent inhibition of development of		
	Catalase	Acid formation from glucose	β-Galactosidase
1	4	0	60
30	5	0	78
300	13	0	83

high values; this finding agrees with that previously recorded for the effect of penicillin on the synthesis of cellular protein in intact staphylococci[1c]. The development of β-galactosidase is, however, highly sensitive to penicillin, being 60 per cent inhibited by a concentration of 1 international unit of penicillin/ml. The sensitivities of the syntheses do not appear to depend upon the conditions promoting the formation of the enzymes; thus the sensitivity of either catalase or β-galactosidase development is significantly the same whether formation takes place in the presence or absence of ribo- or deoxyribo-nucleic acid or the purine–pyrimidine mixture. The incorporation of ^{14}C-uracil which takes place under the conditions of optimal synthesis of β-galactosidase is 65 per cent inhibited by 30 int. units penicillin/ml., whereas that which occurs in the absence of galactose is inhibited to an extent of less than 15 per cent.

Role of Nucleic Acids in Protein Synthesis

Nucleic acids play a part both in the synthesis of proteins and in the incorporation of labelled amino-acids into preformed protein in the disrupted staphylococci preparations used in this work. When a single amino-acid is supplied in the medium, it appears that exchange reactions may occur between that amino-acid and corresponding residues in certain of the cell proteins as long as nucleic acid is present. It would appear that either deoxyribo- or ribo-nucleic acid can render amino-acid residues exchangeable, but it is not yet possible to say whether the same or different proteins are involved in the two cases. No clear explanation can be given of the differing degrees of 'resolution' obtained with incorporation of different amino-acids, unless the activation of amino-acid residues which renders them exchangeable is accomplished by specific fragments of nucleic acid, and some of these fragments are more readily removed or damaged than others.

When all the necessary amino-acids are available and conditions are suitable for protein synthesis, the nature of the protein produced would again appear to be determined by nucleic acids. The experimental facts outlined above could be fitted into a mechanism of protein synthesis occurring along the lines of the following scheme, for which no originality can be claimed: the initial organizing structure or template is either deoxyribonucleic acid or a protein complex containing that acid; this structure is not capable of the synthesis of new protein (although it may bring about exchange reactions in the protein portion), but acts as an organizer for the synthesis of ribonucleic acid; once ribonucleic acid has been constructed, then neo-protein synthesis can take place at a rate dependent upon the amount of specific ribonucleic acid catalyst present. It may be that it is the ribonucleic acid which collects, organizes and orientates amino-acid residues before they split away as protein, or it may be that deoxyribonucleic acid combines with and organizes amino-acid residues which cannot combine into a peptide chain until they have been taken over by the corresponding ribonucleic acid. The comparative effectiveness of ribonucleic acid and a purine–pyrimidine mixture in promoting specific protein synthesis in disrupted cell preparations would then depend upon (1) the ease of synthesis of the specific ribonucleic acid from the purine–pyrimidine mixture, and (2) the stability of the ribonucleic acid once synthesized. Thus, in the case of catalase, the specific ribonucleic acid appears to be stable but not readily synthesized, whereas the formation of β-galactosidase would be explicable if the corresponding ribonucleic acid synthesis were rapid but the product unstable in the absence of inducer. The initiatory role of deoxyribonucleic acid in the case of β-galactosidase formation is shown by the disappearance of response to amino-acids and the purine–pyrimidine mixture in highly resolved preparations treated with deoxyribonuclease, and recovery of response by addition of small amounts of deoxyribonucleic acid. The response to the purine–pyrimidine mixture is accompanied by synthesis of ribonucleic acid, and its essential role in β-galactosidase formation is shown by the loss of response to the purine–pyrimidine mixture and deoxyribonucleic acid in the presence of ribonuclease.

It has been previously shown that penicillin, at growth-inhibitory concentrations, inhibits the incorporation of specific amino-acid residues (under exchange conditions), and it has been suggested that this inhibition results from a blocking of specific interactions between nucleic acids and proteins which would lead, in the growing cell, to failure of the formation of specific proteins[4,6]. In the staphylococci used for this work, β-galactosidase is an example of a protein the formation of which is inhibited by penicillin. The inhibition is again accompanied by inhibition of synthesis of ribonucleic acid.

[1] (*a*) Caspersson, T., *Symp. Soc. Exp. Biol.*, **1**, 127 (1947). (*b*) Caldwell, P. C., and Hinshelwood, C., *J. Chem. Soc.*, 3156 (1950). (*c*) Gale, E. F., and Folkes, J. P., *Biochem. J.*, **53**, 483, 493 (1953).

[2] Austrian, R., *Bact. Rev.*, **16**, 31 (1952). Hotchkiss, R. D., Cold Spring Harbor Symp. Quant. Biol., **16**, 457 (1951). Hershey, A. D., and Chase, M., *J. Gen. Physiol.*, **36**, 39 (1952).

[3] Haurowitz, F., "Chemistry and Biology of Proteins", 326 (Acad. Press, N.Y., 1950). Dounce, A. L., *Enzymologia*, **15**, 251 (1952).

[4] Gale, E. F., "Adv. Protein Chem.", **8**, 287 (1953).

[5] Gale, E. F., Symp. 6th Int. Cong. Microbiol.: Microbiol. Metabolism, 109 (1953).

[6] Gale, E. F., and Folkes, J. P., *Biochem. J.*, **55**, 721 (1953).

[7] Gale, E. F., and Folkes, J. P., *Proc. Biochem. J.*, **55**, xi (1953).

[8] Jones, A. S., *Biochim. Biophys. Acta*, **10**, 607 (1953).

[9] Dutta, S. K., Jones, A. S., and Stacey, M., *Biochim. Biophys. Acta*, **10**, 613 (1953).

[10] Gale, E. F., *Proc. J. Gen. Microbiol.*, **10**, v (1954).

[11] Gale, E. F., and Folkes, J. P., *Biochem. J.*, **55**, 730 (1953).

[12] Gale, E. F., and Epps, H. M. R., *Biochem. J.*, **36**, 608 (1942).

[13] Gale, E. F., and Taylor, E. S., *J. Gen. Microbiol.*, **1**, 322 (1947).

[14] Ledeberg, J., *J. Bact.*, **60**, 381 (1950).

GENETIC POLYMORPHISM IN THE RABBIT IN TASMANIA

By Prof. H. N. Barber

University of Tasmania

THE rabbit (*Oryctolagus cuniculus*) was introduced into Tasmania soon after the first settlement in 1803. It was first recorded wild in large numbers on a few estates in the lower midland pastoral areas north of Hobart in 1827[1]. During the next fifty years it spread over the midlands pastoral region, occupying country with open eucalypt savannah

vegetation and a rainfall of 20–30 in. Towards the end of the nineteenth century it colonized the central plateau region around Great Lake, a region more than 3,000 ft. above sea-level and with a rainfall of 30–40 in. The north-west coastal region and the north-east mountains were first colonized extensively during the past 30–40 years. To-day the rabbit can be found over most of the eastern two-thirds of the island.

In the west the spread of the rabbit has been limited by natural ecological barriers. Apart from a coastal belt about thirty miles wide running along the north-west coast, there are no rabbits in the western third of the island. This area is approximately limited by the 60-in. isohyet. Within this area the main plant communities are dense rain forest with *Nothofagus*, *Atherosperma*, *Anodopetalum*, etc., and peaty button-grass plains with various Cyperaceae (*Mesomelaena*) and Restionaceae dominant. The forest occurs on soils of a higher mineral status and better drainage, while the button-grass community develops on wet, acid soil of very poor mineral status. Where these communities have remained in their virgin state, the rabbit has not penetrated.

Agricultural development of the button-grass community has proved impossible up to the present. Numerous attempts have been made to clear the rain forest for agricultural and pastoral development. In regions of high rainfall (more than 60 in.) and above elevations of 1,500 ft., such attempts have usually failed. The cleared land is now a wilderness covered with dead logs, bracken, and the more resistant undershrubs of the rain forest (for example, *Drimys*, *Leptospermum*, *Cassinia*). In the north-west and north-east dense populations of rabbits exist on such land.

In less than 150 years the rabbit has, thus, colonized a wide variety of habitats in Tasmania. During the summer of 1952–53, an attempt was made to determine if any genetical differentiation had occurred in response to the colonization of the different habitats. Several conspicuous colour variations occur in the rabbit. Counts of the frequency of these variations were made on living populations. In order to avoid bias owing to the different degrees of conspicuousness, the technique adopted was to walk slowly around an area, counting the rabbits as they bolted for cover. In good rabbit country a twenty-minute circuit will result in a count of between 100–200 rabbits. Usually two independent observers made a count on opposite sides of the road. The two counts agreed very well and have been grouped in the data. The majority of counts have been made along transects approximately perpendicular (running north–south) to the northern coast line. The transects start in rich farmlands on the coast and end 15–30 miles inland at altitudes of 1,500–3,000 ft. beyond which the rabbit has scarcely penetrated.

During the survey, nearly 10,000 rabbits were counted. Among the conspicuous colour variations noted are: (1) black, (2) 'blue', (3) yellow, (4) dutch, (5) irregular piebald, and (6) white. Of these, only the black and blue reach frequencies of more than 1 per cent. Among the 10,000 rabbits counted, 10 were dutch (8 agouti, 2 black), 3 yellow, 1 irregular piebald and 2 white. In addition to these major colour variants there are a number of minor variants only visible on trapped animals. They include white spots or stripes on nose and forehead with or without white forepaws. Many of the blacks have a denser or lighter sprinkling with white hairs, and some of them have extensive dorsal areas of chocolate-brown fur. No accurate data exist on the frequencies of these minor variations.

Fig. 1 gives data on the frequency of blacks obtained on three of the transects. The most easterly transect (Great Lake–Deloraine) is about thirty-five miles east of the Nietta transect with the Hampshire transect another 15–20 miles farther west. It will be seen that the blacks increase in frequency to a maximum of 20–35 per cent of the total population in regions of high rainfall at elevations of more than 1,500 ft. Below this region the frequency of blacks falls off until at the coast it is less than 1 or 2 per cent. This clinal pattern is apparent over a region of approximately seventy miles along the north-west coast from Deloraine to Preolenna. There is some evidence that the clines are steepest in the middle of this range, the maximum black frequency decreasing both to the east and west of the central Nietta–Moina region. The same pattern exists on the north-east mountains although here only a single transect has been made. Over the rest of the island isolated counts are available. They show that the frequency of blacks is low (< 2 per cent) in the midland savannah country. The frequency rises to about 10 per cent in the open *Eucalyptus gigantea* forests on the central plateau around Great Lake. Frequencies higher than 20 per cent are always associated with cleared rain forest or mixed eucalypt–rain forest

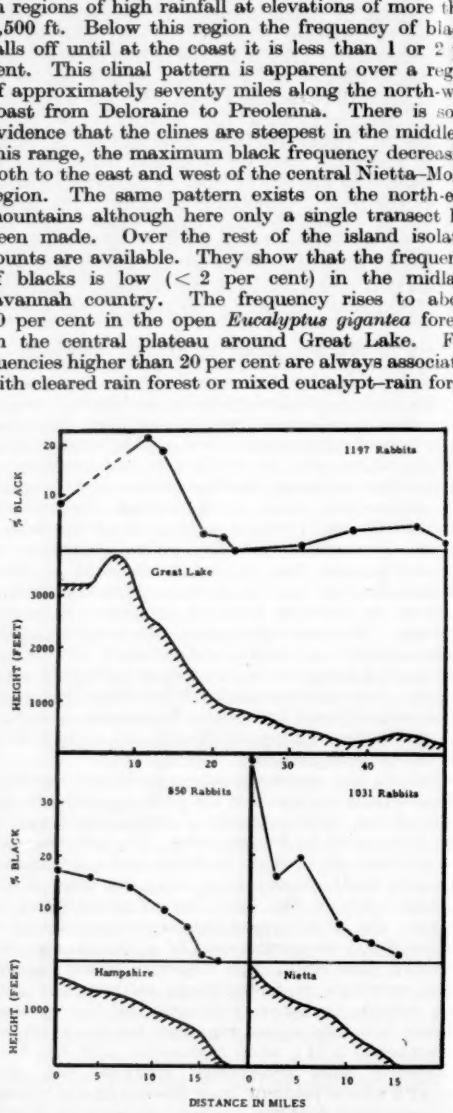

Fig. 1. Diagram of three transects running approximately south–north. Each transect ends near the coast of Bass Strait. An altitude section (vertical magnification approximately × 250) is given immediately below the graphs showing frequency of black rabbits. Total rabbits counted is given for each transect. Minimum number of rabbits used in estimating frequency at any one point is 48; maximum 199; mean 128

with a rainfall of more than 50 in. These relationships are best shown in Fig. 1, the frequency of blacks rising to a maximum in the partially cleared rain forest of the wet escarpment, and decreasing both on the central plateau and on the coastal plain where the vegetation, because of the lower rainfall, is open eucalypt forest. No attempts to estimate accurately the density of the rabbit populations were made. But there appears to be no correlation of the frequency of blacks with density or total numbers. A dense population can show a high or a low frequency of blacks, depending on the ecology of the site.

It is possible that the blue type shows a somewhat similar pattern of distribution, but accurate scoring of this type would involve large-scale trapping. The maximum frequencies are, however, considerably lower than those of the black.

The pronounced ecological correlation shows that the cline in the distribution of the blacks has been built up under the action of natural selection. The wetter regions, usually at altitudes of 1,500–2,500 ft., in some way favour the black. The situation in many respects parallels the distribution of the black hamster (*Cricetus cricetus*) in the southern U.S.S.R. Gershenson[2] has shown that the black hamster may reach frequencies of more than 75 per cent in the humid forest-steppe region of its range. In the dry forest-steppe or mountain forest the frequency of black falls to zero. Guiler[3] has also recently shown that the distribution of the black and grey phases of the Tasmanian brush 'possum (*Trichosurus vulpecula*) shows a pronounced ecological correlation, the black phase again being correlated with heavy rain forest country (cf. Pearson[4]). In all three cases it is impossible at present to specify the advantages conferred by the black genotype in the wetter regions. It is possible that temperature may also be effective in selection. The rain forest localities probably show much less extreme temperature variations than either the alpine eucalypt or the savannah eucalypt forests.

Nothing is known of the genetics of the Tasmanian black rabbit. A few mixed litters of agouti and black and agouti and blue have been dug out. Gershenson[2] has shown that the black type of hamster is caused by a single dominant gene which he thinks may be homologous to the extension black, E^D, of Punnett (see Castle[5]) in the rabbit and black rat. If the black in the Tasmanian populations is caused by this gene, steels (heterozygotes E^DE), in the presumably random mating population, should be commoner than the homozygous blacks (E^DE^D). The genetical constitution of the 'blues' in Tasmania is also unknown. They vary considerably in colour. It is unlikely that they could represent the heterozygous steels since their frequency is much lower than that of the black. It is possible that there has been a selective shift of dominance so that E^D has become completely dominant over E. But it appears more likely that we are dealing with the recessive black (*aa*). Breeding experiments are planned to determine the genetics of these colour types.

It is perhaps significant that the maximum frequency of black observed is 37 per cent. It is more usually 25–30 per cent along the border of the rabbit-free zone in the north-west. If black is recessive, this lower frequency would give the maximum frequency of heterozygotes in a random mating population. It is thus possible to envisage a selection system based on a heterosis effect in the humid rain forest region, selection tending to equalize the allelic frequencies in this region. The black, to human eyes, is much the more conspicuous animal, particularly in the open savannah pastoral districts. Calaby[6] has shown that bird predators may be responsible for the death of 4 per cent of kittens in the Murray Valley region of Australia. The birds may thus exert a counter-selection on black in the open country. Removal or lessening of this selection by increased cover may be one of the factors contributing to the establishment of the cline. Thus, the system of selection in the Tasmanian rabbits may show interesting analogies to that suggested by Ford[7] to explain the origin of industrial melanism in several species of moths. In the moths a heterosis effect is absent, so that when selection against the dominant black mutants is relaxed, the frequency of the black allele rapidly approaches unity.

As regards the time taken to establish the clines, and whether a true equilibrium has been reached, little is definitely known. A maximum time for establishment is certainly less than fifty years. The Parrawe region near Waratah, where blacks reach a frequency of 25–30 per cent, was cleared between 1915 and 1925. Rabbits, according to local report, were absent in the primeval forest. Blacks have been present in the north-east mountains for more than forty years. It thus appears probable that a cline may be established in so short a time as twenty years. If this is the case, it is also probable that equilibrium has been reached. Southern[8] has shown that migration distances are remarkably small for the rabbit in English warrens. If this is so under Tasmanian conditions, it would appear that the cline is a true selection cline and not due to a balance of selection and long-distance migration.

During the survey occasional evidence of myxomatosis was seen. The incidence of the disease in Tasmania since its illegal introduction in the late summer of 1951–52 has been very local. Of the three clines illustrated, the Great Lake–Deloraine cline had been slightly affected around Deloraine (between 20–30 miles). Dense rabbit populations still exist here and no difficulty was experienced in obtaining counts of 100–200 rabbits. It will be interesting to attempt to follow the changes in population density and genetic constitution if sudden fluctuations in density of the rabbit population occur. There is no evidence that any of the mutations studied in this survey confer any increased resistance or susceptibility to attack by the virus. However, the existence of mutants affecting coat colour at possibly more than five loci shows that the Tasmanian rabbit populations may possess an amount of genetic variability affecting other characteristics sufficient to allow them to adapt themselves to myxomatosis almost as quickly as the virus is evolving strains of less virulence[9].

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[1] Stead, D. S., article on "Rabbit" in the "Australian Encyclopedia" (Angus and Robertson, Sydney, 1926).
[2] Gershenson, S., *Genetics*, **30**, 207 (1945).
[3] Guiler, E. R., *Nature*, **172**, 1091 (1953).
[4] Pearson, J., *Pap. and Proc. Roy. Soc. Tas.* for 1937, 2[1] (1938).
[5] Castle, W. E., "The Genetics of Domestic Rabbits" (Harvard Univ. Press, 1930).
[6] Calaby, J. H., *Emu*, **5**[1], 33 (1951).
[7] Ford, E. B., *Biol. Rev.*, **20**, 73 (1945).
[8] Southern, H. N., *Ann. App. Biol.*, **27**, 509 (1940).
[9] Mykytowycz, R., *Nature*, **172**, 448 (1953).

LETTERS TO THE EDITORS

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A Crystalline Material with Xanthine Oxidase Activity

In the course of investigations into the preparation, purification and chemistry of xanthine oxidase from cow's milk, as part of a larger programme of biological and chemical research into functional and structural cellular constituents, we obtained a crystalline material with pronounced enzyme activity.

It was produced by the slow addition, below 0° C., of ethanol (final concentration, 2–7 per cent) to an aqueous concentrate, referred to as 'starting concentrate' (salt content: $M/100$ phosphate buffer, pH 6·2), discarding the initial precipitates. The preparation of these fractions from buttermilk whey followed published methods[1,2], with certain modifications. Under the microscope, small needles, often bunched together in rosettes (Fig. 1), are recognizable. The values in Table 1 give an idea of the properties of two batches, *A* and *B*, of the crystalline materials as compared with the corresponding 'starting concentrates' and the mother liquors of crystallization.

It can be seen that although considerable enzyme activity (columns *e* and *f*) is retained by the mother liquors of the crystals, the latter show an improved 'protein/flavin' ratio (column *d*). On the basis of the calculation given in footnote (*f*), the Q_{O_2} of our best preparation, namely, crystalline material *B*, was 1,580 at 23° C., as compared with Morell's[5] value of 694 at 19° C. It is interesting to mention here that when some of the fractions were tested against methylene blue, the rates of decoloration with hypoxanthine and xanthine as substrates in equal concentrations were the same (Q_{MB} *c.* 1,400; Corran *et al.*[6] reported Q_{MB} 2,420); with acetaldehyde as substrate we found Q_{MB} *c.* 4,200 (Corran *et al.*[6] give 3,500).

With regard to the composition of enzyme preparations, Philpot[7] has distinguished in the concentrate of Corran *et al.*, just mentioned, three components, called γ, δ (main fraction) and ε, when submitting it to examination in the ultracentrifuge. Sedimentation experiments with our materials indicated that ε was barely detectable in all our runs, while γ was present in the starting concentrate *A* but was reduced in the crystalline material *A* and *B* to negligible amounts (Figs. 2 and 3). This was reflected in a fall in the corresponding 'protein/flavin' ratios (Table 1, column *d*). The colour was associated with the main fractions in each case. Preliminary molecular weight calculations based on such ultracentrifuge results indicated a molecular weight of about 200,000 for our main fraction. Electrophoresis experiments, so far carried out with 'starting concentrates' only (by Mr. D. W. F. James), showed on the whole one peak.

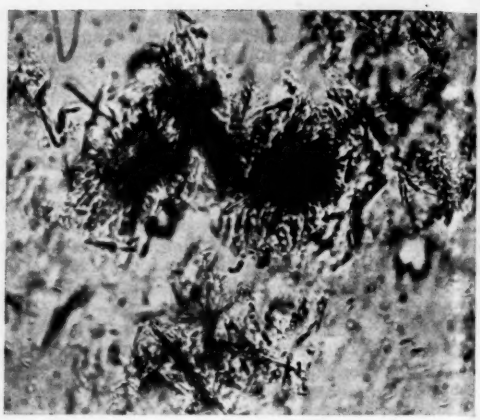

Fig. 1. Crystalline material *A*. (× 375)

In accord with Green and Beinert[8], molybdenum was found in all fractions; while crystalline material *B* came up to *c.* 0·03 per cent[9], all other fractions contained rather less, namely, *c.* 0·02 per cent. FAD estimations carried out fluorimetrically[10] infer an FAD/Mo ratio of approximately the published order[9,11]. Richert[12] has recently reported the occurrence of iron in his milk xanthine oxidase preparations. While we found iron[13], we are not yet certain whether this metal forms an integral part of the active lacto-xanthine oxidase molecule.

It is more than likely that even our best crystalline material obtained to date represents a mixture of active xanthine oxidase and perhaps slightly denatured enzyme of the same molecular weight; the difference between crystals *A* and *B* can be clearly discerned in Table 1; the ratio $\frac{\text{activity (units/l.)}}{E(450\ \text{m}\mu)}$

Table 1

a	*b*	*c*	*d*	*e*	*f*
Material	Batch	Dry weight (gm.)	Ratio: $\frac{\text{'Protein}}{\text{Flavin'}}$	Ratio: $\frac{\text{Activity (units/l.)}}{E(450\ \text{m}\mu)}$	Ratio: $\frac{\text{Activity (units/l.)}}{E(280\ \text{m}\mu)}$
'Starting concentrate'	*A*	0·32	7·4	39	5·3
	B	1·98	8·5	62	7·3
Crystalline material	*A*	0·13	5·3	32	6·1
	B	0·35	5·1	53	10·4
Mother liquors	*A*	0·13	7·5	34	4·4
	B	0·48	12·4	57	4·6

a, 'Starting concentrate' as in text; crystalline material centrifuged, washed and redissolved: mother liquor without washings.

c, Calc. from $E(280\ \text{m}\mu)$ with $E(1\%, 1\ \text{cm.}) = 11$ (value based on Cl_3CCO_2H method (ref. 3) and Kjeldahl-nitrogen).

d, Ratio: $\frac{E(280\ \text{m}\mu)}{E(450\ \text{m}\mu)}$; pH 7·2.

e, Spectrophotometric assay method (refs. 4 and 5), with xanthine, pH 8·2, 23° C. Units = [($\triangle E$(1 cm., 295 mμ)/min.) × overall enzyme dilution × volume of sample (in litres)].

f, This is related to conventional Q_{O_2} = above ratio × 152 [taking $E(1\%, 1\ \text{cm.}) = 11$ and $\triangle E$ (oxid. 1 μgm. xanthine/ml.) = 0·064] (see ref. 5).

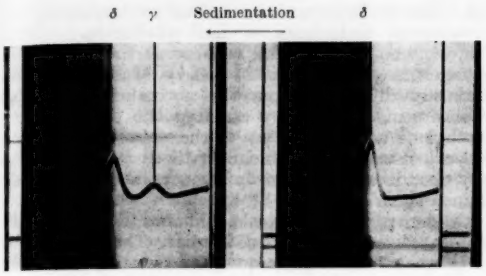

Fig. 2 Fig. 3

Sedimentation diagram using a 3-cm. column of liquid, the solvent being phosphate buffer of *p*H 6·2; (2) original concentrate *A*; (3) crystalline material *A*

is regarded as being largely dependent on the relative amounts of active and inactive enzyme in the sample (see also ref. 5). So far we have not been successful in separating the functionally active portion from the closely related inactive one, as no operations with the crystalline or other material in our hands have yet brought about an improvement in the above ratio. The nature of the difference between active and inactive enzyme, as well as their chemistry, will form the subject of further studies. Details of our findings, reported briefly above, will be published elsewhere.

We are grateful to Prof. A. Haddow for his support, encouragement and continued interest. We wish to thank Prof. H. D. Kay and Miss H. Chapman, of the National Institute for Research in Dairying, for their assistance in supplying us with buttermilk, Dr. M. Dixon and Dr. H. M. Kalckar for their helpful criticism, and Dr. P. M. Cowan and Dr. W. E. Seeds for crystallographic advice. We acknowledge technical assistance by Mrs. K. Tussler and Mr. T. Stebbings. This investigation has been supported by grants to the Royal Cancer Hospital and Chester Beatty Research Institute from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund, and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service.

P. G. Avis
F. Bergel
R. C. Bray
K. V. Shooter

Chester Beatty Research Institute,
Institute of Cancer Research:
Royal Cancer Hospital,
Fulham Road,
London, S.W.3.
May 31.

[1] Ball, E. G., *J. Biol. Chem.*, **128**, 51 (1939).
[2] Horecker, B. L., and Heppel, L. A., *J. Biol. Chem.*, **178**, 683 (1949).
[3] Hoch, F. L., and Vallee, B. L., *Anal. Chem.*, **25**, 317 (1953).
[4] Kalckar, H. M., *J. Biol. Chem.*, **167**, 429 *et seq.* (1947).
[5] Morell, D. B., *Biochem. J.*, **51**, 657 (1952).
[6] Corran, H. S., Dewan, J. G., Gordon, A. H., and Green, D. E., *Biochem. J.*, **33**, 1694 (1939).
[7] See ref. 6; addendum by Philpot, J. St. L.
[8] Green, D. E., and Beinert, H., *Biochim. Biophys. Acta*, 11, 599 (1953).
[9] Richert, D. A., and Westerfeld, W. W., *J. Biol. Chem.*, **203**, 915 (1953).
[10] Burch, H. B., Bessey, O. A., and Lowry, O. H., *J. Biol. Chem.*, **175**, 457 (1948).
[11] Totter, J. R., Burnett, jun., W. T., Monroe, R. A., Whitney, I. B., and Comar, C. L., *Science*, **118**, 555 (1953).
[12] Richert, D. A., *Fed. Proc.*, **13**, 279 (1954).
[13] Kellin, D., and Hartree, E. F., *Biochem. J.*, **39**, 289 (1945).

Stereochemistry of Certain Analgesics

We are investigating the configurational relationships existing among a group of optically active analgesics all of which possess one asymmetric centre. In 'Methadone' and related compounds it has been shown[1–3] that almost the whole of the analgesic activity resides in one of the isomers.

We have established that the analgesically active isomers '(−)-methadone' ((−)-6-dimethylamino-4 : 4-diphenylheptan-3-one), (−)-ethyl-1 : 1-diphenyl-3-dimethylaminobutyl sulphone, and (+)-3-dimethylamino-1 : 1-(2′-thienyl)-but-1-ene, possess identical configurations which are related to D-(−)-alanine. These relationships were established in the following way. The hydrolysis of (−)-ethyl-1 : 1-diphenyl-3-dimethylaminobutyl sulphone gives (−)-3-dimethylamino-1 : 1-diphenylbutan-1-ol[4]. This alcohol, after dehydration followed by reduction, gave (+)-3-dimethylamino-1 : 1-diphenylbutane, which was also obtained from (−)-4-dimethylamino-2 : 2-diphenylpentane nitrile, the precursor of (−)-methadone. L-Ethyl-3-dimethylaminobutyrate, derived from phthaloyl-L-alanine via an Arndt–Eistert reaction followed by reductive methylation, was treated with phenyl magnesium bromide to yield (+)-3-dimethylamino-1 : 1-diphenylbutan-1-ol. Reaction of this same ester with thienyl lithium gave (−)-3-dimethylamino-1 : 1-(2′-thienyl)-butan-1-ol, which gave (−)-3-dimethylamino-1 : 1-(2′-thienyl)-but-1-ene on dehydration.

In a recent communication, Bick[5] has advanced evidence from which he concludes that morphine is configurationally related to L-(+)-alanine. His argument relates the two substances via apomorphine and laudanosine and depends on the validity of a method of assigning configuration first employed by Leithe[6,7]. Leithe maintained that the specific rotation of bases possessing analogous asymmetric centres and of like configuration are displaced in the same direction when examined in a series of solvents of increasing polarity.

Because the validity of Leithe's method has not been rigidly established, we have determined the specific rotations, in a series of solvents, of the compounds shown in Table 1. The configurations of these compounds are identical and have been established as described above. It is evident that in this series no relationship exists between configuration and direction of specific rotational change brought about by an increase in the polarity of the solvent.

We are therefore of the opinion that the method used by Bick to establish the relationship of morphine and apomorphine to the L-amino-acids is of doubtful value. Furthermore, we consider that the configurational assignments given by Leithe to alkaloids of the laudanosine and berberine type are not conclusive.

The identical configurations of the analgesically active isomers reported in this communication; the antagonistic action exhibited by N-allylnormorphine ('Nalorphine') towards morphine and many of the synthetic analgesics; the antagonistic action towards morphine shown by (−)-N-allyl-3-hydroxymorphinan but not by the corresponding (+) isomer[8]; the identical configurations of (−)-N-allyl-3-hydroxymorphinan and (−)-3-hydroxy-N-methyl-morphinan[9] (the isomer which is analgesically active whereas the (+)-isomer is inactive) give further support to the statement[10] made some time ago by one of us (A. H. B.) that "before analgesic action can be mediated directly or indirectly, it is possible that the stereochemical

Table 1

	$[\alpha]_D^{20}$			
$Me.CH(NMe_2).CH_2.CPh_2.R$	Base in *cyclo*-hexane	Base in benzene	Base in ethanol	Hydro-chloride in water
R = —CO.Et	−34·4 (C=1·2)	−24·0 (C=1·3)	−26·0 (C=1·5)	−125 (ref. 11) (C=1·5)
R = —SO_2.Et	—	+12·0 (in acetone (ref. 12) C=2·0)	0 (ref. 12) (C=2·0)	−31·6 (ref. 12) (C=5·0)
R = —CN	−65·1 (C=0·9)	−59·5 (C=0·8)	−50·9 (C=0·8)	+6·0 (ref. 11) (C=5·0)
R = —H	−66·2 (C=4·8)	−50·3 (C=4·7)	+12·0 (C=3·4)	+52·7 (C=1·0)
R = —CO_2.Et	−85·5 (C=2·0)	−73·8 (C=1·8)	−50·0 (C=1·8)	−37·3 (C=1·0)
R = —OH	+36·8 (C=0·8)	+32·6 (C=1·9)	−27·3 (C=0·8)	−45·1 (C=1·0)
$Me.CH(NMe_2).CH:CPh_2$	+128 (C=1·0)	+123 (C=1·0)	+170 (C=1·0)	+213 (C=0·9)

The effect of concentration upon the specific rotation is not significant in comparison with the effect of the solvent.

configuration of the drug must be complementary to that of a certain tissue surface or enzyme system". The presence of specific receptor sites for analgesic action is now a probability rather than a possibility.

A detailed account of the investigation of certain structural aspects of analgesics will be published elsewhere.

A. H. Beckett
A. F. Casy

Pharmaceutical Chemical Laboratory,
School of Pharmacy,
Chelsea Polytechnic,
London, S.W.3.
Feb. 12.

[1] Eddy, N. B., Touchberry, C. F., and Liebermann, J. E., *J. Pharmacol.*, **98**, 121 (1950).
[2] Lewis, J. R., *J. Pharmacol.*, **96**, 31 (1949).
[3] Green, A. F., *Brit. J. Pharmacol.*, **8**, 2 (1953).
[4] Archer, S., and Auerbach, M. E., *J. Amer. Chem. Soc.*, **73**, 1840 (1951).
[5] Bick, R., *Nature*, **169**, 755 (1952).
[6] Leithe, W., *Oesterr. Chem. Ztg.*, **35**, 133 (1932).
[7] Leithe, W., *Berichte*, **67**, 1261 (1934).
[8] Fromherz, K., and Pellmont, B., *Experientia*, **8**, 394 (1952).
[9] Schnider, O., and Grüssner, A., *Helv. Chim. Acta*, **34**, 2211 (1951).
[10] Beckett, A. H., *J. Pharm. Pharmacol.*, **4**, 425 (1952).
[11] Larsen, A. A., Tullar, B. F., Elpern, B., and Buck, J. S., *J. Amer. Chem. Soc.*, **70**, 4194 (1948).
[12] Tullar, B. F., Wetterau, W., and Archer, S., *J. Amer. Chem. Soc.*, **70**, 3959 (1948).

Influence of Vitamin C on the Utilization of Sulphate labelled with Sulphur-35 in the Synthesis of Chondroitin Sulphate of the Costal Cartilage of the Guinea Pig

It has been reported that sulphate when administered to the rat is retained by cartilage, bone and bone marrow[1], and it is now further established that the sulphate is mainly incorporated into the chondroitin sulphate of the cartilage[2–4]. Since the utilization of the sulphate administered in the formation of chondroitin sulphate lends itself to quantitative determinations, this was used by us for studying the influence of vitamin C on the formation of this sulphuric ester in the costal cartilage of the guinea pig. The evidence so far obtained by employing the histological techniques is not conclusive. Thus, Höjer[5], who was the first to observe the atrophy of collagen in the cartilage in scurvy, was not able to find any difference from the normal in regard to chondroitin sulphate by staining the sections with methylene blue. Contrary to the above observation, Meyer[6], using basic metachromatic dyes, did not find any chondroitin sulphate in the cartilage of scorbutic guinea pigs.

Guinea pigs, eight weeks old and weighing 246–304 gm., were used in these studies. They were given large quantities of green leafy material for one week before the experiment and the scorbutic diet[7] for the whole of the experiment. In addition, each guinea pig received 1 ml. of cod liver oil twice a week. Fresh tap water was also given daily. They were weighed once in four days. Twenty-six guinea pigs, consisting of equal numbers of males and females, were maintained on the scorbutic diet for nineteen days, and the typical symptoms of scurvy such as cessation of food intake, loss in weight and the tenderness of the joints were noticed. During the third week, three males and three females died. Twenty-six guinea pigs, consisting of equal numbers of males and females, received, in addition to the above scorbutic diet, 4 mgm. *l*-ascorbic acid *per os* each day. One guinea pig in the male group was found to be sick on the second day of the experiment and was discarded. The rest were healthy throughout the experimental period and steadily gained in weight.

On the nineteenth day of the experiment, the guinea pigs, both deficient and normal, were given intraperitoneally 0·02 mc. sodium sulphate-35 in dilute aqueous solution per 100 gm. body-weight. After the administration of the sulphate, they were maintained for 48 hr. under the dietary conditions described above. At the end of the period they were killed, and the costal cartilage was removed. The chondroitin sulphate from the cartilage was prepared

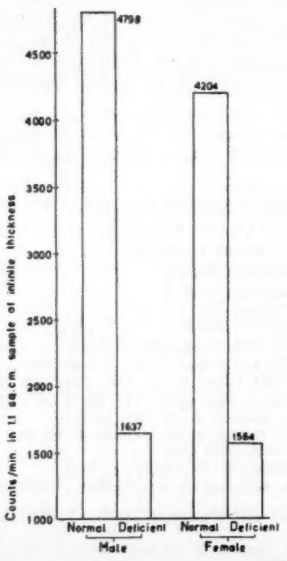

Fig. 1. Radioactivity of barium sulphate obtained from chondroitin sulphuric acid, prepared from the costal cartilage of normal and deficient guinea pigs. Normal—basal diet + 4 mgm. vitamin C/day. Deficient—basal diet only

according to the method of Jorpes[8] as modified by Strandberg[9] and by Boström[3].

80 mgm. of chondroitin sulphate was hydrolysed with 5 ml. of 6 *N* hydrochloric acid in a steam-bath for 4 hr. The sulphate was precipitated as barium sulphate and collected in a tared gooch crucible, ignited and weighed. 20 mgm. of barium sulphate was suspended in 50 per cent alcohol and collected on a filter paper on a perforated aluminium disk. The precipitate was washed with absolute alcohol and ether, and radioactivity was measured in a Geiger–Müller counter with a 2·1-mgm. per sq. cm. mica end window. After the counts were taken, the samples were dried at 105° C. and the weights were checked.

The results in Fig. 1 show that the sulphate administered is incorporated into the chondroitin sulphate of the costal cartilage. The utilization of the sulphate in the formation of chondroitin sulphate was not significantly affected by variations in sex. But, however, there is a significant difference between normal and deficient guinea pigs in their utilization of the administered sulphate in the formation of chondroitin sulphate. The average incorporation in the deficient animal was about one-third that of the normal. The esterification of the sulphate group appears to be a very sensitive indicator for the metabolic disturbances in the cartilage in scurvy.

We are indebted to Prof. Erik Jorpes for facilities and for his interest during the course of this investigation, and also to Prof. Håkan Rydin, who offered us facilities for conducting the animal experiments in the State Pharmaceutical Laboratory.

K. K. Reddi*
Aina Nörstrom

Chemistry Department II,
Caroline Institute,
Stockholm.
Nov. 11.

* Present address: Division of Applied Biology, National Research Council, Ottawa.

[1] Singher, H. C., and Marinelli, L., *Science*, **101**, 414 (1945). Dziewiatkowski, D. D., *J. Biol. Chem.*, **178**, 197 (1949).
[2] Dziewiatkowski, D. D., *J. Biol. Chem.*, **178**, 389 (1949). Dziewiatkowski, D. D., Benesch, R. E., and Benesch, R., *J. Biol. Chem.*, **178**, 931 (1949).
[3] Boström, H., *J. Biol. Chem.*, **196**, 477 (1952).
[4] Boström, H., *Ark. Kemi*, **6**, 43 (1953).
[5] Höjer, A., *Acta Paediatrica*, **3**, Supp. 17, 60 (1924).
[6] Meyer, A., *Z. Vitaminforsch.*, **14**, 332 (1944).
[7] Harris, L. J., and Olliver, M., *Biochem. J.*, **36**, 155 (1942).
[8] Jorpes, E., *Biochem. Z.*, **204**, 354 (1929).
[9] Strandberg, L., *Acta Physiol. Scand.*, **21** 222 (1950).

Diffusion of Alkaline Phosphatase to Characteristic Intracytoplasmic Sites of Activity

While using superimposed frozen-dried sections of rat kidney for the study of diffusion phenomena[1] in the Gomori[2]–Takamatsu[3] technique for alkaline phosphatase, it was observed that faint staining of the brush border regions occurred in the underlying inactive section in very occasional tubules. This result was obtained after moderately prolonged incubation, even when inactivation of the underlying section was effected by heat. The appearances suggested that the enzyme itself, enzyme activator or phosphate ion was diffusing into the underlying section, and prompted further experiments to demonstrate enzyme diffusion to characteristic positions in the cell[4].

Fig. 1. Frozen-dried section of rat kidney heated at 95° C. for one minute, incubated at 37° C. in kidney mash suspension for one hour, washed in distilled water and incubated in glycerophosphate medium for four hours

Frozen-dried 5-μ sections of rat kidney were deparaffinized in xylene, immersed in absolute alcohol for three minutes and passed through 50 per cent alcohol to water. The slides were then immersed in distilled water at 95° C. for one minute, which was shown in the control sections to inactivate the enzyme completely. They were next incubated at 37° C. in a solution containing 0·4 per cent sodium veronal and 0·4 per cent calcium nitrate to which was added a fine mash of fresh rat kidney. This solution had a *p*H (glass electrode measurements) of 8·7 before and 8·5 after one hour's incubation. After brief washing in distilled water the slides were incubated in the usual glycerophosphate medium, and sites of activity demonstrated by final precipitation of cobalt sulphide. After treatment of the inactivated section for one hour in the kidney mash suspension and subsequent incubation with substrate for four hours, staining was observable in the brush border regions of the tubules and in most nuclei throughout the kidney (Fig. 1). Shorter times of incubation in the two media produced similar but less intense results. Enzyme transfer could similarly be effected to heat-inactivated frozen-dried sections of rat duodenum.

Sections were also inactivated with 0·25 per cent nitric acid, 0·1 *N* hydrochloric acid, 10 per cent acetic acid and saturated mercuric chloride solutions. Substantially similar results were obtained after incubation with the mash suspension, although the nuclear appearances varied with the method of inactivation. With mercury-inactivated sections, treatment with a filtrate from a mash suspension previously heated to 95° C. for one minute resulted in reappearance of enzyme activity in characteristic sites. This filtrate had no effect in restoring enzyme activity in heat-inactivated sections.

Similar results were obtained with a mash suspension in distilled water with sections inactivated by mercuric chloride; but the nuclear staining was much less intense than in sections treated with the mash suspension in a sodium veronal – calcium nitrate solution. Mash suspended in distilled water had only a slight effect on sections inactivated with 0·25 per cent nitric acid, brush borders and very occasional nuclei being just visible. The fact that heated homogenate will not reactivate heated sections excludes the possibility that the diffusing substance is phosphatase activator (unless the latter is heat labile).

These findings point conclusively to the diffusion of alkaline phosphatase to normal as well as to other sites in the cell. Taken in conjunction with those of Gomori[4] and Novikoff[5], they suggest that something in addition to the enzyme and not calcium ions or sodium veronal is necessary to effect such transfer. There is some indication, however, that these latter substances may facilitate enzyme diffusion or its attachment in the cell. Such findings do not detract from the usefulness of the method provided that properly designed controls are used in any particular study.

The demonstration of diffusion of alkaline phosphatase and its attachment to other, as well as to characteristic, sites in the cell suggests that erroneous conclusions may be drawn from analysis of its activity in homogenate fractions. The use of histochemical controls thus seems to be essential in such studies.

I wish to express my gratitude to Prof. J. F. Danielli for his guidance in this and other studies on alkaline phosphatase.

R. Barter*

Zoology Department, King's College,
University of London,
Strand, London, W.C.2.
Feb. 22.

* Nuffield Foundation Dominion Travelling Fellow in Medicine.

[1] Danielli, J. F., *J. Exp. Biol.*, **22**, 110 (1946).
[2] Gomori, G., *Proc. Soc. Exp. Biol., N.Y.*, **42**, 23 (1939).
[3] Takamatsu, H., *Trans. Soc. Path. Japan*, **29**, 492 (1939).
[4] Gomori, G., *J. Lab. Clin. Med.*, **35**, 802 (1950).
[5] Novikoff, A. B., *Science*, **113**, 320 (1951).

A Quantitative Method for Enzyme Cytochemistry applied to Alkaline Phosphatase

In the Gomori–Takamatsu technique for localizing alkaline phosphatase, tissue sections are incubated in a solution containing a phosphate ester and calcium ions. The phosphate ions liberated as a result of enzyme activity are precipitated in the section as calcium phosphate, which is made visible by converting it to cobalt sulphide. The cobalt sulphide is dark brown and gives only a rough indication of the degree of enzyme activity. A quantitative method[1] has recently been developed for measuring the mass of substances (other than water; that is, dry mass) in cells. It has been shown that the dry mass can be determined from measurements of optical path difference which can be made with an interferometer microscope. This note describes measurements made with this technique of the amounts of calcium phosphate deposited as a result of phosphatase activity. We have found that the interferometer-microscope method can be used to study the magnitude of possible artefacts due to diffusion of enzyme and diffusion of the calcium phosphate. We have also found that interferometry provides a most promising approach to the quantitative determination of enzyme activity at sites in cells.

Previous observations by Moe[2] with the Gomori–Takamatsu technique indicated that after initial precipitation large-scale diffusion of calcium phosphate may occur from the sites of precipitation to other sites in the section. For example, after about one minute's incubation a heavy deposit of calcium phosphate was found in the intestinal brush border. But after an hour's incubation the brush border appeared to contain no calcium phosphate, and other previously negative sites now became positive. Ruyter[3] showed that these results were open to another interpretation, namely, that the calcium phosphate precipitated in brush borders changes its reactivity and can no longer react with the Gomori–Takamatsu reagents. Observations[4] by phase-contrast microscopy confirmed Ruyter's observations that the processes discovered by Moe do not, in fact, involve a diffusion but rather a change in the physical state of the calcium phosphate. However, unlike the interferometer microscope, the phase-contrast microscope gives only a rough indication of the amount of calcium phosphate.

In our experiments, frozen-dried 4-μ sections of either rat kidney or duodenum, fixed in absolute alcohol for three minutes, were mounted in water in a chamber for continuous observation and measurement with a Dyson[5] interferometer microscope, made by Cooke, Troughton and Simms, Ltd., objective numerical aperture 1·3. The optical path difference of a site in the brush border was first determined and the section then perfused with a solution of *p*H 9·3 containing 0·4 per cent sodium glycero-phosphate, 0·4 per cent sodium veronal, 0·2 per cent calcium nitrate and 0·04 per cent magnesium chloride. The increase in optical path difference due to deposition of calcium phosphate was recorded as a function of time. Fig. 1 shows results obtained with the brush border of the rat kidney. The rate of deposition is approximately constant for about twenty-five minutes and then slowly diminishes with time. The calcium phosphate was removed from the section with buffered distilled water (*p*H 7·0) and the section again perfused with the same substrate solution at *p*H 9·3. Measurements at the same site in the brush border showed the same rate of increase of calcium phosphate as found originally (Fig. 1). We have repeated these experiments six times on a single section (total incubation time, three hours) and have

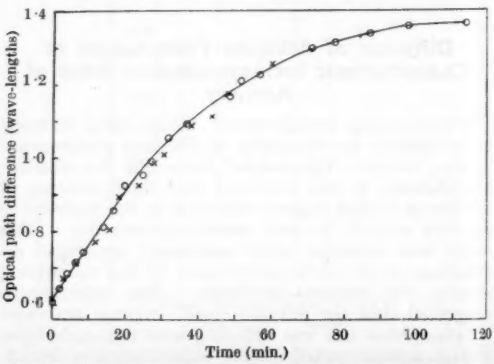

Fig. 1. Increase in optical path difference (proportional to mass of calcium phosphate per unit area) in kidney brush border during first incubation (○) and second incubation (×)

found that the rate of deposition of calcium phosphate is unaltered within the limits of experimental error. These results indicate that under these conditions the amount of enzyme activity in the brush border of rat kidney remains constant.

In order to find out if calcium phosphate, once formed, can diffuse, the section containing calcium phosphate was immersed in the incubation solution without substrate. After twenty-four hours in this solution at *p*H 9·3 no change in optical path difference in the brush border, and hence no change in amount of calcium phosphate, could be detected. Therefore, under these conditions calcium phosphate apparently does not diffuse once it has been precipitated.

An important advantage of this technique is that the enzyme activity at one site in one cell can be measured repeatedly under various conditions and a check finally made to see if the enzyme activity under the initial conditions remains unchanged. The following factors which affect both the rate of liberation of phosphate ions and the rate of deposition of calcium phosphate are being investigated: *p*H; temperature; type and concentration of substrate; concentrations of calcium ions, buffers and activators. The rate of deposition of calcium phosphate during the linear phase, per unit dry mass of tissue, under certain defined conditions of *p*H, etc., may be used as a quantitative measure of enzyme activity. A full report of these investigations will be published elsewhere.

This technique can be used for the cytochemical study of any other enzymes which, as a result of their activity, produce a measurable change in optical path difference.

We wish to thank Prof. J. T. Randall for his encouragement and for providing facilities for this work, and Dr. L. G. Bell for his guidance in the freeze-drying of tissues. Part of the expense of this research has been defrayed by a grant from the Rockefeller Foundation.

H. G. Davies

Medical Research Council
Biophysics Research Unit,
Wheatstone Laboratory,
King's College, London.

R. Barter*
J. F. Danielli

Department of Zoology,
King's College, London.

* Nuffield Foundation Dominion Travelling Fellow in Medicine.

[1] Davies, H. G., and Wilkins, M. H. F., Cytochemistry Commission of the Society for Cell Biology "Physical Aspects of Cytochemical Methods" (Stockholm, 1951); *Nature*, **169**, 541 (1952). Barer, R., *Nature*, **169**, 366 (1952). Davies, H. G., Wilkins, M. H. F., Chayen, J., and La Cour, L. F., *Quart. J. Micro. Sci.* (in the press).

[2] Moe, H., *Anat. Rec.*, **112**, 217 (1952).

[3] Ruyter, J. H. C., *Acta Anat.*, **16**, 209 (1952).

[4] Danielli, J. F., *Proc. Roy. Soc.*, B, **142**, 146 (1954).

[5] Dyson, J., *Proc. Roy. Soc.*, A, **204**, 170 (1950).

Chemical Composition of the Golgi Apparatus in the Exocrine and Endocrine Cells in the Pancreas of the Mouse

It has recently been shown that pancreas cells (exocrine and endocrine) contain a canal-like Golgi apparatus distinct from all other cell inclusions[1]. Since then I have used various histochemical tests to determine the chemical composition of this canalicular structure.

It has often been suggested that the Golgi apparatus contains a lipid capable of reducing silver nitrate and osmium tetroxide. In support of this view, I have found that when pancreatic tissue is treated first with lipoidal solvents (ether–alcohol, acetone) and then by Aoyama's silver method, there is a total failure to impregnate any inclusions. However, the apparatus remains uncoloured when Baker's[2] sudan-black method for lipids is used. The reason for this latter result appears to be that the lipid is 'masked' in some way, for it can be coloured with sudan black if the tissue is fixed in Aoyama's fluid, treated with 1½ per cent silver nitrate for 17 hr., washed and embedded in gelatin. In an attempt to determine whether this lipid contains a phospholipin, I used the acid hæmatin test exactly as described by Baker[3] and, in addition, after the previous use of silver nitrate as an 'unmasking agent'. The full results, in both cases, are as follows: Golgi apparatus = negative; mitochondria = positive; lipoidal bodies = negative; zymogen granules = positive; islet granules = positive.

At least two significant points have emerged from the use of the acid hæmatin test. First, I have shown previously[1] that sudan black does not colour zymogen or islet granules (and only occasionally mitochondria) and yet all contain a phospholipin. Therefore a negative result with sudan black does not prove the absence of certain lipids (for example, phospholipins). Secondly, the results seem to disprove the main conclusion reached by Palade and Claude[4] that the Golgi apparatus is an artefact produced by the action of classical fixatives (particularly Aoyama's fluid) on inclusions rich in phospholipins. My work indicates that: (1) the Golgi apparatus does not contain any phospholipins, and (2) inclusions containing phospholipins (mitochondria, zymogen granules and islet granules) are not distorted in any way by the action of Aoyama's fixative.

Attempts have been made to decide whether the Golgi apparatus contains a protein or a carbohydrate. Weigl[5] managed to stain bleached Kopsch preparations with resorcsin–fuchsin, which usually stains proteinacious connective tissue (see Baker[2]). However, when fresh resorcsin–fuchsin, made up from Weigl's original formula, was used on bleached Aoyama preparations in pancreas cells, there was a total failure to colour the apparatus. Millon's test for protein also gave a negative result. Negative results were obtained for glycogen and mucin (Bauer–Feulgen test[6]) and muco-polysaccharides (Evan's blue method used in conjunction with freeze-drying[7]). Nevertheless, there is still reason for believing that the Golgi apparatus does contain a protein and/or carbohydrate, since it is preserved by freeze-drying[8].

It has often been suggested that vitamin C may be associated with the Golgi apparatus (see Bourne[9]). Accordingly, Bourne's test[3] for ascorbic acid was used. A negative result was obtained in the regions where both the Golgi canals and adjacent lipoidal bodies occur, namely, mainly in the zone basal to the zymogen granules. Thus it would appear that whereas the Golgi apparatus or lipoidal bodies may segregate vitamin C under certain conditions[9], the vitamin does not constitute an essential or permanent part of either organelle. Similarly, it has been suggested that alkaline phosphatase might occur in the Golgi apparatus[9]. However, when Gomori's[6] method was used on pancreas cells, I failed to detect alkaline phosphatase in the Golgi zone although a strong reaction was obtained in capillaries.

I am indebted to Dr. A. J. Marshall for his support in this work and would like to thank Prof. J. Rotblat,

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Dennis Lacy
Department of Zoology and Comparative Anatomy,
St. Bartholomew's Medical College,
London, E.C.1. March 16.

[1] Lacy, D., *J. Roy. Micro. Soc.* (in the press).
[2] Baker, J. R., *Quart. J. Micr. Sci.*, **85**, 1 (1944).
[3] Baker, J. R., *Quart. J. Micr. Sci.*, **87**, 441 (1946).
[4] Palade, G. E., and Claude, A., *J. Morph.*, **85**, 71 (1949).
[5] Weigl, quoted from Bowen, R. H., *Anat. Rec.*, **40**, 103 (1928).
[6] Gatenby, J. B. and Beams, H. W., "Microtomists' Vade Mecum" (edit. 11, Churchill, London, 1950).
[7] Pearse, A. G. E., "Histochemistry, Theoretical and Applied" (Churchill, London, 1953).
[8] Lacy, D., *J. Roy. Micro. Soc.* (in the press).
[9] Bourne, H. B., "Cytology and Cell Physiology" (Clarendon Press, Oxford, 1951).

Solubility of Oxygen in Water

The rate at which self-purification can occur in waters polluted by oxidizable organic matter may depend largely on the rate at which oxygen from the air is dissolved by the water. In natural water the rate of solution is influenced by many variable factors; but Adeney and Becker[1] have stated that for constant conditions, and for a uniformly mixed body of water, it is proportional to the difference between the concentration of oxygen in solution and the saturation or equilibrium concentration. Unfortunately, the absolute saturation values are not known with great precision; indeed, some of the values published by several independent investigators differ by as much as 0·4 part of oxygen per million at temperatures in the range 0°–35° C. The most generally accepted values are, however, those quoted by the American Public Health Association in "Standard Methods for Examination of Water and Sewage"[2]; these are based on gasometric determinations by C. J. J. Fox[3].

In an investigation to provide information about the effect of natural variable factors on surface aeration, we have made many measurements of rates of aeration of pure water, the concentration of dissolved oxygen being determined by the Winkler[4] titration method using an amperometric end-point[5] in the final titration of iodine. We have consistently found that over a range of temperature 0°–35° C. the Adeney and Becker law of aeration is not satisfied when rates of solution of atmospheric oxygen are evaluated from the difference between the accepted saturation values and the dissolved oxygen concentration of the solution determined by the Winkler method. This discrepancy arises because the accepted saturation values are higher than the values obtained when the concentration of oxygen in water in equilibrium with atmospheric oxygen is determined by the Winkler method. This is a matter of some importance since it is the Winkler method which is most commonly used for the determination of dissolved oxygen and hence of rates of solution both in the laboratory and in field investigations.

In our experiments, the concentration of oxygen in deionized distilled water was either reduced or increased to a value well below or above the saturation value at a given temperature; the water was then slowly stirred to bring it into equilibrium with an atmosphere of air which had been saturated with water vapour and from which carbon dioxide had been removed. Measurements of dissolved oxygen were made at intervals until several successive samples, taken over a period of days, gave a constant value when corrected for changes in atmospheric pressure. This value was assumed to be the saturation concentration at the temperature of the experiment. The results obtained by this procedure are related by the empirical equation $C_s = 14{\cdot}16 - 0{\cdot}3943T + 0{\cdot}007714T^2 - 0{\cdot}0000646T^3$, where C_s equals saturation concentration in parts of oxygen per million and T equals temperature in degrees C. The standard error of the curve is 0·05 part of oxygen per million. A comparison between these values and those determined gasometrically by Fox are shown in Fig. 1. It is noteworthy that much better agreement with Adeney and Becker's law of aeration may be obtained with these saturation values than with the generally accepted ones. Moreover, for the purpose of determining rates of solution in natural waters, these saturation values are less 'artificial' than the accepted values in that they were obtained in waters in equilibrium with atmospheric oxygen rather than with pure oxygen in a sealed apparatus. It is of interest in this connexion that Holroyd and Parker[6] in their work on the dynamics of aeration have reported that they were unable to approach the accepted saturation values, though they attributed this to a thermometric error.

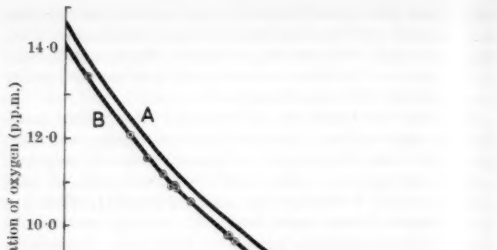


Fig. 1. Curve *A*, saturation values taken from "Standard Methods" calculated by Whipple and Whipple on measurements made by C. J. J. Fox (atmosphere assumed to contain 20·9 per cent oxygen); curve *B*, saturation values determined by the Winkler method

The discrepancy between the saturation values we have obtained and the standard values has stimulated interest in the determination of absolute saturation values. A number of gasometric determinations of the saturation value of oxygen at 25° C. have been made in this laboratory, and the results so far obtained are in close agreement with the value calculated from the above equation at this temperature. These investigations are being continued, and a full account will be published elsewhere.

G. A. Truesdale
A. L. Downing
Water Pollution Research Laboratory,
Langley Road, Watford, Herts. March 4.

[1] Adeney, W. E., and Becker, H. G., *Phil. Mag.*, 6, **38**, 317 (1919).
[2] American Public Health Association, "Standard Methods for the Examination of Water and Sewage" (ninth edition, New York, 1946).
[3] Fox, C. J. J., *Trans. Farad. Soc.*, **5**, 68 (1909).
[4] Winkler, L. W., *Ber. Dtsch. Chem. Ges.*, **21**, 2843 (1888).
[5] Knowles, G., and Lowden, G. F., *Analyst*, **78**, 159 (1953).
[6] Holroyd, A., and Parker, H. B., *J. Inst. Sew. Purif.*, Part 3, 292 (1949).

Volumetric Method for the Determination of Zirconium

KUMINS[1] observed that mandelic acid separates zirconium quantitatively from a large number of elements, and its use as a specific reagent for zirconium is being extended in analytical practice[2–4], in preference to the time-honoured methods of affecting the separation as phosphate or basic selenite[5]. In a series of papers, Klingenberg and his colleagues[6,7] have investigated the possibility of using α-hydroxy carboxylic acids as specific reagents for zirconium determinations and have shown that a direct weighing of *p*-chloro- and *p*-bromo-mandelates of zirconium is a satisfactory procedure for the gravimetric determination of the metal. The halo-derivatives of mandelic acid exert a large weighting effect on the zirconium ion and further, unlike the zirconium mandelate, these are not water-soluble. Hahn[8] has further explored the use of *p*-bromo-mandelic acid for the determination of the zirconium – hafnium ratio by a computation from the combined weights of the *p*-bromo-mandelate of zirconium and hafnium and the weight of the oxides obtained therefrom by ignition. Jonckers[9] has studied the reactivity of groups in relation to their application to inorganic analysis.

We have been engaged in a study of the cerimetric oxidation of organic acids and have found that mandelic acid can be quantitatively oxidized by ceric sulphate[10,11]: the volume of ceric salt consumed can be used as a measure of the mandelic acid content. It was also noted that the same reaction can be extended to *p*-chloro- and *p*-bromo-mandelic acids.

In the present investigation we have explored the possibility of developing a volumetric method for the determination of zirconium by taking advantage of the above reaction.

Zirconium tetra *p*-chloro-mandelate was precipitated from a known volume of the zirconium solution by following the method of Klingenberg, filtered through a sintered-glass funnel of medium porosity, washed, dried and weighed. The halo-mandelate was dissolved from the crucible by a hot solution of ammonia, the solution acidified and boiled for fifteen minutes with a known excess of standard ceric sulphate solution. The excess was titrated back with standard ferrous sulphate solution using ferroin as internal indicator. The reaction may be represented as follows:

$$Zr(Cl.C_6H_4CH(OH).COO)_4 + 8Ce(SO_4)_2 \rightarrow Zr(SO_4)_2 + 4Ce_2(SO_4)_3 + 4Cl.C_6H_4CHO + 4CO_2 + 2H_2SO_4;$$

or 1 gm.mol. of zirconium tetra *p*-chloro-mandelate reacts with 8 gm.mol. of ceric sulphate. Similar reactions apply to the zirconium tetra *p*-bromo-mandelate, and the same procedure was followed for precipitating, dissolving and titrating the zirconium salt.

In Table 1 are given typical figures obtained on 2 ml. each of a sulphuric acid solution of zirconium oxide.

It may be seen from the above that the cerimetric oxidation method is applicable to the volumetric determination of zirconium, and the results obtained are reproducible with a great degree of accuracy. The method is being extended to the determination of zirconium in ores and steels. It gives promise of application to even smaller quantities, and full details will be published elsewhere.

Table 1

Method of determination	Wt. of zirconium oxide found (gm.)
(*a*) Gravimetric (phosphate method)	0·007633
(*b*) Gravimetric (from wt. of *p*-chloro-mandelate)	0·007590
(*c*) Volumetric (from vol. of ceric sulphate used for the chloro-mandelate)	0·007641
(*d*) Gravimetric (from wt. of the *p*-bromo-mandelate)	0·007582
(*e*) Volumetric (from vol. of ceric sulphate used for the bromo-mandelate)	0·007614

Our thanks are due to Dr. R. C. Shah, of the National Chemical Laboratory of India, Poona, who supplied the halo-mandelic acids, and to Sir K. S. Krishnan, director of the National Physical Laboratory of India, for his kind interest in the work and his permission to publish this communication.

MULK RAJ VERMA
SUKH DEO PAUL
National Physical Laboratory of India,
Hillside Road,
New Delhi.
Jan. 30.

[1] Kumins, C. A., *Anal. Chem.*, **19**, 376 (1947).
[2] Gavioli, G., and Traldi, E., *La Metallurgia*, **42**, 179 (1950).
[3] Mills, E. C., and Hermon, S. E., *Analyst*, **78**, 256 (1953).
[4] Hahn, R. B., *Anal. Chem.*, **21**, 1579 (1949).
[5] Hillebrand, W. F., and Lundell, G. E. F., "Applied Inorganic Analysis", 446 *et seq.* (John Wiley, New York, 1948).
[6] Klingenberg, J. J., and Oesper, R. E., *Anal. Chem.*, **21**, 1509 (1949).
[7] Klingenberg, J. J., and Papucci, R. A., *Anal. Chem.*, **24**, 1861 (1952).
[8] Hahn, R. B., *Anal. Chem.*, **23**, 1259 (1951).
[9] Jonckers, M. D. E., *Chim. Anal.*, **32**, 207 (1950). Cf. *Chem. Abs.*, **45**, 61 (1951).
[10] Verma, M. R., and Paul, S. D., *J. Sci. and Indust. Res.*, **12**, B, 178 (1953).
[11] Verma, M. R., and Paul, S. D., *J. Sci. and Indust. Res.* (in the press).

Structure of Pristimerin

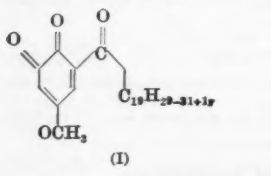
Bhatnagar and Divekar[1] described the isolation of an antibiotic, an orange-coloured pigment which they called 'pristimerin', from *Pristimerae indica* and *P. grahami* (Celastraceae). They found that this compound is particularly active against the *viridans* group of streptococci. We have been studying the constitution of this complex molecule.

Pristimerin crystallizes in orange needles of melting point 218–219° from petroleum ether – benzene. On the basis of analytical results and molecular weight (429) determined by X-rays (private communication from Prof. J. D. Bernal to Col. S. S. Bhatnagar), it has been assigned a molecular formula $C_{28}H_{36-38}O_4$. The physical and chemical properties and infra-red and ultra-violet spectroscopic evidence show it to be a β-quinone derivative. It contains one methoxy group and gives a negative Zerewitinoff test for active hydrogen. The latter observation finds confirmation in the infra-red absorption spectrum, in which the —OH band is absent. Reductively acetylated or methylated pristimerin (melting points 246° and 186° C. respectively) shows ultra-violet absorption suggestive of an acetoxylated or methoxylated benzene ring system, thus indicating that pristimerin may be a derivative of β-benzoquinone and not of naphthaquinone, nor of a quinone containing fused-ring systems of more than two aromatic rings.

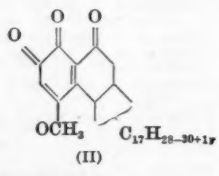
Methylated pristimerin contains three methoxy groups and one double bond, and forms 2-4 dinitrophenylhydrazone, showing that the fourth oxygen in

the molecule is ketonic in nature. Lithium aluminium hydride reduces the orange solution of pristimerin in ether to a colourless solution which on acidification and aeration becomes orange in colour. Furthermore, two compounds (melting points 165° C. (dec.) and 205° C. (dec.)) without the methoxy group originally present in the molecule are obtained. The physical and chemical properties of these show that they still have β-quinone structure and are keto-enol isomers. Ultra-violet absorption curves of these compounds show that the third —CO— group, which is reduced to —CHOH— by lithium aluminium hydride, is probably conjugated with the β-quinone system. The fact that pristimerin does not form derivatives with ketonic reagents or orthophenylene diamine and gives a positive test with boroacetic anhydride and tin tetrachloride suggests that the third keto group is sterically hindered and is probably in the peri-position to the β-quinone grouping. The labile character[3] of the —OMe group towards lithium aluminium hydride, acids or alkalis indicates its presence in the quinone part of the molecule, probably in a grouping OMe—C=C—C=O. Thus the chemical and physical data so far obtained can well be interpreted by the following tentative partial structure (I).

Preliminary selenium dehydrogenation experiments indicate that the molecule may be a steroid or triterpenoid. In view of this and of the fact that triterpenes have been isolated from this species of the plant, the partial structure (I) may possibly be further elaborated to (II).



(I)



(II)

Celastrol[3], a quinone isolated from *Celastrus scandens* L., was assigned a molecular formula $C_{22}H_{30}O_3$. It appeared more than a coincidence that the melting points of pristimerin and the methyl ether of celastrol are the same. Ultra-violet absorption curves of pristimerin and celastrol are very similar, and both the compounds were isolated from the same family of the plant; hence a mixed melting point of pristimerin with methyl celastrol was taken. No depression was observed, showing that pristimerin and methyl celastrol are probably identical.

A complete account of this investigation will be published elsewhere. We are grateful to Col. S. S. Bhatnagar for suggesting this work and supplying pristimerin, to Prof. J. D. Bernal for determining molecular weight by the X-ray method, to Prof. O. Gisvold for sending a sample of methyl celastrol, and to Dr. V. M. Thakore for his collaboration in the initial stages of this work. We thank Dr. Bholanath for the preliminary experiments on selenium dehydrogenation.

A. B. Kulkarni
R. C. Shah

National Chemical Laboratory,
Poona 8, India. March 8.

[1] Bhatnagar and Divekar, *J. Sci. Indust. Res.*, **10** B, 56 (1951).
[2] Karrer and co-workers, *Helv. Chim. Acta*, **33**, 803, 812 (1950). Feiser, *J. Amer. Chem. Soc.*, **48**, 2925 (1926).
[3] Gisvold, *J. Amer. Pharm. Soc.*, **28**, 449 (1939); **29**, 12 (1940); **31**, 529 (1942). Feiser and Jones, *J. Amer. Pharm. Soc.*, **31**, 315 (1942). Schechter and Haller, *J. Amer. Chem. Soc.*, **64**, 182 (1942).

Half-life of Curium-242

The most recently published value for the half-life of curium-242 is that of Hanna, Harvey and Moss[1], namely, 162·5 ± 2 days. This was determined by observing the proportions of americium-241 and curium-242 in samples of neutron-irradiated americium by pulse analysis methods over periods of up to one year.

The present measurements have been made by direct counting of α-particles from a source of pure curium which had been exhaustively purified from americium by ion-exchange methods. The α-counter used was of the low-geometry proportional type[2] designed for high precision and long-term stability[2].

The curium source was deposited on a polished platinum disk. It was practically weightless, and gave initially about 2×10^7 α-disintegrations per minute. During a period of about seven months, fourteen measurements were made, each to a statistical accuracy of ± 0·1 per cent (that is, at least 10^6 counts were recorded).

It was necessary to correct for the growth of the long-lived α-active daughter, plutonium-238, and for this purpose the half-lives of curium-242 and plutonium-238 were taken as 162·5 days and 89 years respectively; but as these corrections amounted to less than one per cent of the counting-rate in every case, the final result is not critically dependent on these assumptions.

The corrected counting-rates were fitted by the least squares method to a linear relationship of the form:

$$\ln C_t = \ln C_0 - \lambda t,$$

where C_0 and C_t are the corrected counting-rates at time 0 and time t respectively, and λ is the decay constant of curium-242. The deviations of the experimental points from this straight line were quite random and showed no detectable trend with time, as would be expected if the sample contained any long-lived contaminant (for example, americium-241 of curium-243), or if the correction for plutonium-238 were inaccurate. The results were consistent with the existence of random effects producing a standard deviation of ± 0·1 per cent in addition to the standard deviation of ± 0·1 per cent due to counting statistics.

The slope of the least squares line gave a half-life value of 162·46 days with a standard deviation of ± 0·27 day.

K. M. Glover
J. Milsted

Chemistry Division,
Atomic Energy Research Establishment,
Harwell, Didcot, Berks.
Feb. 9.

[1] Hanna, G. C., Harvey, B. G., and Moss, N., *Phys. Rev.*, **78**, 617 (1950).
[2] Hall, G. R., and Hurst, R., *Analyst*, **77**, 970 (1952).
[3] Glover, K. M., and Hall, G. R., *Nature* [**173**, 991 (1954)].

In connexion with the work described above, we have attempted to provide a check on the half-life of curium-242 by the entirely independent method of calorimetry.

A sample of approximately 2 μgm. of curium-242, slightly less pure than that used above, was kindly made available to us by Dr. J. Milsted. We have determined the total heat output of this sample at

intervals over a period of twelve months, using a specially designed twin microcalorimeter which gave a precision of measurement of approximately ± 1·5 microwatt (± 0·00086 cal./hr.). The small size of the sample and consequent very low heat outputs (400 μW. at the beginning, falling to 100 μW. at the end of the experimental period) seriously limit the precision attainable in the determination of the half-life; but the results appear to be sufficiently precise to confirm the value already published.

After correcting for the plutonium-238 daughter produced on decay, and for a small amount of a long-lived contaminant, we have computed the half-life from each pair of our results, using the formula:

$$\tau_{1/2} = \frac{0{\cdot}693t}{2{\cdot}303\,(\log_{10} A_t - \log_{10} A_0)},$$

t being the time interval in days and A_t and A_0 the heat outputs corresponding to times t and zero respectively.

The mean value obtained is 163·0 days with a standard deviation of ± 1·8 days. A detailed account of this work is to be published elsewhere.

W. P. Hutchinson
A. G. White

Chemistry Division,
Atomic Energy Research Establishment,
Harwell, Didcot, Berks.

Feb. 4.

Speed of Circulation in Droplets

The initiation of circulation in the form of vortex rings in droplets in motion in another liquid has been shown to depend on such physical properties as the viscosity of both the liquid in the droplet and of the outer liquid, and also particularly on the character of the interface. An attempt is now being made to obtain the velocity of circulation inside such liquid droplets in relation to their speed of fall or rise under varying conditions.

In preliminary experiments, droplets of redistilled nitrobenzene containing aluminium particles were allowed to fall through a 0·5 per cent w/w solution of 'Cellofas B' in tap water (viscosity *c.* 12 centipoises) contained in a square cross-sectioned column of dimensions 30 in. × 2 in. × 2 in. Their fall was photographed using a 16-mm. ciné camera to give a magnification of 1/3, and the camera table was counterbalanced by a weight and pulley system so that with judicious hand pressure the path of the droplet could be followed. High-powered side-lighting was used, and the amount of aluminium in the dispersed phase was such that, with a camera speed of 64 frames per sec., dark streaks were recorded on the film by reflexion from the individual particles. A series of frames showing the fall of a droplet were enlarged by projection and, with each image of the droplet occupying the same position on the screen, successive streaks made by the same particle were plotted to trace the streamlines of circulation (Fig. 1).

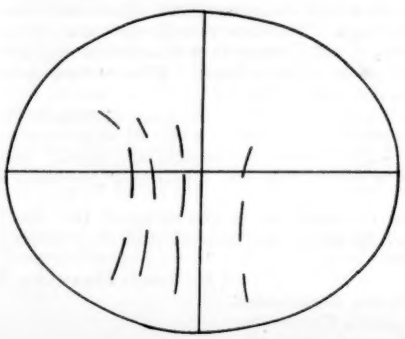


Fig. 1. The farther the streaks from the centre of the droplet, the greater their elongation due to refractive distortion

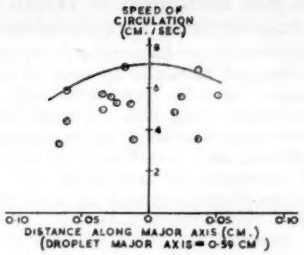


Fig. 2

From the length of the streaks and the frame-speed of the camera, the velocities along each streamline were obtained. After allowing for refraction at the interface by geometrical construction, these velocities were plotted against the distance from the centre of the droplet to the intersection of the streamline and the major axis.

The envelope of these points represents the velocity distribution in the vertical plane through the centre of the drop perpendicular to the optical axis, and its peak gives the highest circulation velocity. (Points below this envelope represent motion in other vertical planes, Fig. 2.)

For a droplet of major and minor axes equal to 0·59 cm. and 0·47 cm. respectively, this velocity was found to be 7·3 cm./sec. compared with a fall velocity of 13·4 cm./sec. For a spherical droplet the maximum possible circulation velocity is equal to 1·5 times the velocity of fall, so that it can be inferred that the circulation in this particular droplet is about 30 per cent of its maximum possible value.

The velocity of circulation decreased during fall; but as no attempt was made to eliminate injection effects due to the nozzle, it is not yet clear whether this was due to a change in the interfacial properties or not.

During the analysis there is a difficulty in accurately measuring the velocities, especially of particles at 'apparent' distances from the centre greater than half the radius. The work is being continued using liquids of the same refractive index in order to obtain the circulation velocity distribution more accurately, particularly nearer the surface of the droplet. It may then be possible to show how the relative rate of circulation varies with the physical properties of the system, and hence throw more light on the phenomena influencing the initiation of circulation.

F. H. Garner
A. H. P. Skelland
P. J. Haycock

Department of Chemical Engineering,
University,
Birmingham 15.

March 15.

Infra-Red Dichroism of Nylon and Polyethylene Terephthalate

In this laboratory we have been studying for some time the polarized infra-red spectra of single fibres and filaments. A 0·78 N.A. reflecting microscope of our own design, used with a Perkin–Elmer Model 12-*C* infra-red spectrometer in an arrangement similar to that of Blout, Bird and Grey[1], has allowed examination of specimens as narrow as 20 microns in width. Polarized radiation was obtained with a silver chloride sheet transmission polarizer. The very thin specimens required for the fundamental region of the spectrum were prepared by either longitudinally sectioning or mechanically flattening the single fibres.

A series of drawn specimens of nylon 66 and polyethylene terephthalate, kindly supplied by E. I. du Pont de Nemours and Co., Inc., have yielded results of particular interest. A summary of dichroic ratios observed for a number of absorption bands in specimens of different (nominal) draw ratio is given in Table 1. Each value represents the average of measurements made on 8–15 single filaments, and has been corrected for scattering losses, but not for the effect of beam convergence in the reflecting microscope. We have found that the latter correction is small, and does not alter the general results. It was also established that no appreciable double orientation was present in the specimens.

Table 1. Dichroic Ratio ($\varepsilon_\pi/\varepsilon_\sigma$)

	cm.$^{-1}$	Draw ratio					
		1	2·02	2·99	3·99	5·02	5·99
Nylon 66	3,310	0·98	1·35	1·25	0·92	0·79	0·84
	3,075	1·37	1·86	0·74	0·42	0·42	0·46
	2,930	0·92	1·23	1·20	0·96	0·90	0·99
	2,860	0·98	1·34	1·13	0·80	0·77	0·78
Polyethylene terephthalate	1,021	0·88	0·98	1·17	1·46	1·69	1·53
	975	0·43	1·61	2·04	3·43	3·92	3·63

It is seen that the four nylon absorption bands exhibit parallel dichroism at the lower draw ratios, and change over to perpendicular dichroism as the drawing proceeds. Hitherto, only perpendicular dichroism has been observed for these bands in highly oriented films[2,3]. The 3,310 cm.$^{-1}$ N—H stretching vibration and the two methylene stretching motions at 2,930 and 2,860 cm.$^{-1}$ change dichroism in unison, as would be expected since the corresponding transition moments are all perpendicular to the chain axes. The 3,075 cm.$^{-1}$ band, the assignment of which is still in doubt, exhibits greater extremes in dichroic ratio, and changes from parallel to perpendicular character at an earlier stage. At draw ratios of 1 and 2 there is evidence that the extent of parallel dichroism for the 3,075 cm.$^{-1}$ band may be affected by the degree to which the filaments are flattened prior to infra-red examination[4]. This effect has not been observed for the other three bands of nylon 66.

We have observed that the change in dichroic character at about draw ratio 2·02 is quite general throughout the spectrum of polyethylene terephthalate. In addition to the 1,021 and 975 cm.$^{-1}$ bands, at least six other bands in the region 1,500–700 cm.$^{-1}$ reverse their initial dichroism as a result of drawing. The dichroism of the highly drawn filaments agrees in general with the results of Miller and Willis[5].

In the nominally undrawn condition (draw ratio 1), dichroism was found to be present in the polyethylene terephthalate, and to a lesser extent in the nylon, even though the undrawn filaments of both showed very low birefringence. The X-ray patterns of undrawn nylon indicated an unoriented, crystalline structure; on drawing, orientation was induced but with little change in crystallinity. The polyethylene terephthalate, initially amorphous, developed crystallinity on drawing, most markedly between draw ratios 2·99 and 3·99, where an inflexion in its birefringence curve appeared. In neither material, however, did X-ray patterns or birefringence measurements give evidence of a major reversal of chain orientation which the infra-red results alone might imply.

These results indicate that measurements of infra-red dichroism of fibres may reveal chain orientation which is not detected by the usual X-ray and optical techniques. Holmes *et al.*[6] have reported that the amorphous regions in stretched polyethylene film are oriented at nearly right angles to the crystalline regions. It is possible that in poorly oriented fibre specimens the amorphous regions have a chain orientation quite different from that attained in the fully drawn, crystalline material, and that at the lower extensions the orientation of the amorphous regions largely determines the infra-red dichroism. Keller's recent suggestion[7] of helical structures in synthetic polymers offers another very attractive explanation of some of these results, and is being investigated further.

Richard G. Quynn
Richard Steele

Textile Research Institute,
Princeton, New Jersey. Feb. 6.

[1] Blout, E. R., Bird, G. R., and Grey, D. S., *J. Opt. Soc. Amer.*, **40**, 304 (1950).
[2] Ambrose, E. J., Elliot, A., and Temple, R. B., *Proc. Roy. Soc.*, A, **199**, 183 (1949).
[3] Bamford, C. H., *et al.*, *Proc. Roy. Soc.*, B, **141**, 49 (1953).
[4] Caroti, G., and Dusenbury, J. H. (private communication; Textile Research Institute).
[5] Miller, R. G. J., and Willis, H. A., *Trans. Farad. Soc.*, **49**, 433 (1953).
[6] Holmes, D. R., *et al.*, **171**, 1104 (1953).
[7] Keller, A., *J. Polymer Sci.*, **11**, 567 (1953).

Rotational Analysis of the Columbium Oxide Bands

In a previous communication[1], the rotational constants determined for the ground and excited states of the columbium oxide molecule have been reported as derived from the rotational analysis of the three bands λ 4,510 (1,0), λ 4,689 (0,0) and λ 4,915 (0,1). Due to an error, which has unfortunately crept in, in the calculation of the r_e values, it has since been found necessary to revise the analysis and to redetermine the constants. This work has been carried out. The two *R* and the two *P* branches and the *K*-numbering have been confirmed from the combination relationships. The revised rotational constants are:

B''_0 = 0·3447 cm.$^{-1}$	B''_0 = 0·3776 cm.$^{-1}$
B'_1 = 0·3420 "	B'_1 = 0·3746 "
B'_e = 0·3461 "	B'_e = 0·3791 "
α'_e = 0·0027 "	α''_e = 0·0030 "
I'_e = 80·852 × 10^{-40} gm. cm.^{2}	I''_e = 73·814 × 10^{-40} gm. cm.^{2}
r'_e = 1·889 A.	r''_e = 1·805 A.

The *D*-values are of the order of 10^{-7} cm.$^{-1}$.

Full details of this analysis will be published elsewhere.

K. Suryanarayana Rao

Physics Department,
Andhra University,
Waltair. Feb. 17.

[1] Rao, K. S., *Nature*, **170**, 670 (1952).

Direct Measurement of Intensity Distributions in Star Images

MEASUREMENTS of the distribution of light intensity in the images of a star, formed by lenses, may be made with photomultiplier techniques. The experimental evidence so provided is of immediate application to the theory of the resolution of optical instruments, permitting confirmation of rigorous calculations, for example, those of Airy[1] for the aberration-free axial case, of Martin[2] for the axial case with aberration and of Hopkins[3] for the general case at a position in the field of a system with aberrations. Another use for these measurements is in checking the accuracy of approximate methods of image calculation[4]. Apparatus based on photomultipliers has generally been designed to employ a slit probe, for facility of image location and in order to keep the incident flux at a convenient level. Results have been obtained by Ingelstam[5], Schade[6], Lindberg[7] and Sprosen[8] in this way, and R. E. Hopkins[9] has used a circular aperture to measure the proportion of the total energy which falls within a chosen diameter of the total energy which falls within a chosen diameter of the image. The measurements made by these means need to be converted by the appropriate mathematical techniques in order to arrive at the requisite distributions. Direct intensity distribution measurements are evidently desirable provided the experimental difficulties of image location and low light level can be overcome.

An experimental arrangement has been developed for use with photographic lenses, having a 'point' probe which is small compared with the star image and which may be translated through sufficiently small distances to enable the image to be charted; facility is also provided for the location of the image. The photoelectric response of the multiplier has been found to be sufficient for this purpose, even at moderate dynode voltages, when using a condensed high-pressure mercury source. The experimental equipment is represented in Fig. 1 and comprises an artificial star, formed by the pinhole S and collimator C, a test lens L which forms an image of the star in the working plane of the microscope objective O and the photocell aperture A defining the region of the star image from which energy will be received. To the microscope is added a side-tube containing a monitor system; a thin (unsilvered) glass plate M and eyepiece E, which is set for line and made parfocal with the primary system by a subsidiary optical technique. The field of the eyepiece E is provided with a grid graticule so that co-ordinates of the position of the image of A in the working plane of O and also co-ordinates of the position of the star image are readily specified. Thus the star image is located. The image scan is accomplished by moving the object pinhole S through a small distance across axis, using the optical reduction of the collimator and test lens system to provide the very small image displacement required. The probe diameter is taken to be the reduced diameter of aperture A in the working plane,

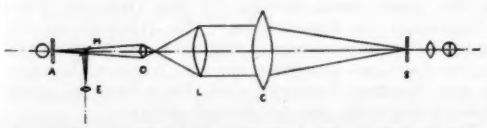


Fig. 1. Experimental arrangement, comprising pinhole S illuminated by the source, collimator lens C, test lens L, microscope objective O, beam splitter M, receiving aperture A and eyepiece E

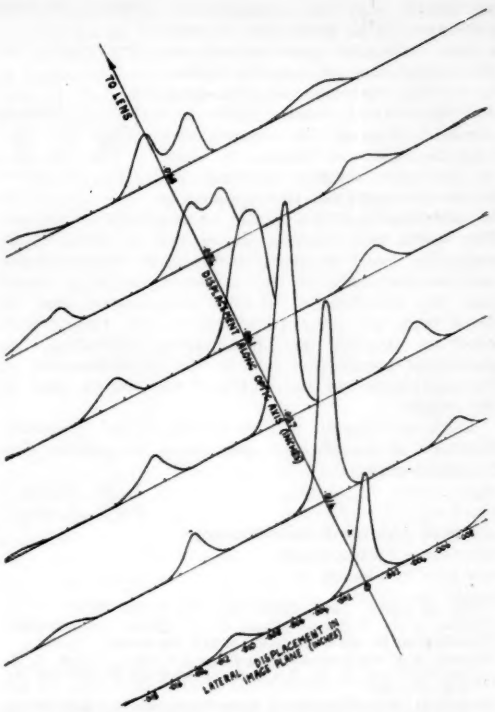


Fig. 2. Intensity distribution in a star image. Cross-sections of the image are shown at several planes near focus. Intensity is shown vertically in arbitrary units

and without difficulty this may be made less than 1/30 of the diameter of the star image formed by a photographic lens of moderate or large focal length.

Preliminary work with this apparatus has given satisfactory results for a telephoto lens of 36 in. focal length and aperture $f/6{\cdot}2$. Star images are commonly of the order of 0·0015 in. diameter in such cases; accordingly the probe diameter was made approximately 0·00005 in. by using an objective of 8 mm. focal length, the aperture A having a diameter of about 0·001 in. The object pinhole was moved through a distance of the order of 0·005 in. in the focal plane of a collimator of $3\frac{1}{2}$ times the focal length of the test lens. In Fig. 2 the image cross-sections are shown for a series of transverse planes in the neighbourhood of focus. Intensity is shown in arbitrary units vertically and lateral displacement is shown in intervals of 0·002 in. The traces are shown for planes displaced at equal intervals of 0·0135 in. along a third axis through the origin. These curves present a self-consistent model in agreement with standard results for a lens with appreciable under-corrected spherical aberration[10] and which conforms with the general pattern of distributions calculated for other lenses of the same focal length[4]. In the plane of best instrumental focus, at 0·027 in. along axis from the origin, the central maximum has a half-width of 0·0018 in. and the first ring has a radius of 0·011 in., a comparatively large value. There is also a weak second ring at approximately twice the radius of the first ring. This ring structure cannot be detected visually in the general flare surrounding the image core, as the variations in intensity

are small, and the photoelectric technique seems preferable in such a case. Detailed developments in the apparatus are needed before trying to correlate experimental and theoretical results with the precision desired. At present the reproducibility of results is only 5 per cent, largely because of source fluctuations, the apparatus is inflexible and the taking of readings is tedious. The work, nevertheless, shows that a useful technique for direct intensity distribution measurements may be developed on this principle, and it is hoped that the specification of lens performance may be freed from the restrictions imposed by the present need to depend on photographic recording. A particular application lies in the determination of the significance of the width of the central part of the image.

Acknowledgment is due to the Chief Scientist, Ministry of Supply, for permission to publish this communication.

J. M. Naish
P. G. Jones

Royal Aircraft Establishment,
Farnborough.
March 4.

[1] Airy, Sir George, *Trans. Camb. Phil. Soc.*, **5**, 283 (1834).
[2] Martin, L. C., "Technical Optics", **1**, 125 (Pitman, London, 1948).
[3] Hopkins, H. H., *Proc. Roy. Soc.*, A, **217**, 408 (1953).
[4] Bracey, R. J. (publication confidential to B.S.I.R.A.). Naish, J. M., and Mathieson, B. M., R.A.E. Technical Notes Ph. 482 and 484, Fig. 11 (1953).
[5] Ingelstam, E., Proc. Symp. on Image Evaluation, Nat. Bur. Stands. (1951).
[6] Schade, O. H., *J. Soc. Mot. Pict. Telv. Eng.*, **56**, 137 (1951); **58**, 181 (1952).
[7] Lindberg, P. J., *J. Opt. Soc. Amer.*, **42**, 748 (1952).
[8] Sprosen, W. N., *B.B.C. Quart.*, **8** (1) (1953).
[9] Hopkins, R. E., Proc. Symp. on Image Eval., Nat. Bur. Stands. (1951).
[10] Martin, L. C., "Technical Optics", **2**, 261 (Pitman, London, 1948).

Oxygen Uptake and Carbon Dioxide Evolution of Heat-sterilized Soil

In a study of the respiration of soils at temperatures ranging from 10° to 70° C., it was found that oxygen uptake and carbon dioxide evolution increased with increasing temperature above 50° C.[1]. The decline in plate counts at the higher temperatures indicated a gas exchange due to heat-stable enzymes or chemical oxidation and decarboxylation.

An investigation was then made on the gas exchange of soils subjected to various heat-sterilization treatments (Table 1).

These results show that the oxygen uptake increases with increasing severity of heat treatment. This suggests that the effect of heating is to expose oxidizable groups in the soil either by direct reduction or by the disruption of some fractions of the organic matter. The evolution of carbon dioxide from heated soils at 30° C. was low in comparison with oxygen uptake, but other work[1] has shown that the ratio of carbon dioxide to oxygen in autoclaved soils increases as the temperature at which respiration is being studied is increased.

Table 1. Effect of Heat Treatment on Gas Exchange of Soil. (μl./gm. oven-dry soil/hr. at 30° C.)

	Untreated soil	Heated to 85° C. for 2 days	Steamed for 1 hr. on 3 successive days	Autoclaved at 15 lb./sq. in. 1 hr.	2 hr.	3 hr.
O_2	19	1·4	5·9	7·0	8·5	9·0
CO_2	18	0·7	1·7	1·2	1·3	1·2
Ratio CO_2/O_2	0·9	0·5	0·29	0·17	0·16	0·14

Table 2. Gas Exchange of Unheated and Autoclaved Soil at 30° C. in the Presence of Biological Inhibitors (μl./gm./hr.)

	Unautoclaved soil				Autoclaved soil			
	No inhibitor	Sodium azide	Sodium chloride	Mercuric chloride	No inhibitor	Sodium azide	Sodium chloride	Mercuric chloride
O_2	18	2·0	0·9	3·0	18	15	21	20
CO_2	17	3·0	1·3	2·5	2·9	0·7	1·7	1·9

The narrow carbon dioxide/oxygen ratio, the non-inhibition by microbial and respiratory inhibitors (Table 2) and the temporary nature of the gas exchange (Table 3) in the heat-sterilized soils are further evidence that the gas exchange is due to chemical oxidation.

Table 3. Gas Exchange at 30° C. of Autoclaved Soil at Various Periods after Heating (μl./gm./hr.)

	Time after autoclaving (15 lb./sq. in. for 1 hr.)			
	1 hr.	5 hr.	6·5 hr.	9 days
O_2	25	13	12	0·8
CO_2	8·6	4·3	3·9	0·6

The gas exchange of soil nine days after autoclaving is probably indicative of the chemical oxidation which occurs in soils at normal temperatures. This oxidation, while not significant in comparison with microbial respiration at normal temperatures, increases with increasing temperature. In exposed inland Australian soils, where temperatures of 47°–50° C. occur at one inch depth for several hours per day during summer months[2], the chemical oxidation could be a significant factor in the decline in organic matter.

J. S. Bunt
Australian National Antarctic Research Expedition,
187 Collins Street,
Melbourne.

A. D. Rovira
Agricultural Microbiological Laboratories,
Faculty of Agriculture,
University of Sydney.
Feb. 10.

[1] Bunt, J. S., and Rovira, A. D., *J. Soil Sci.* (In the press).
[2] West, E. S., *Aust. J. Sci. Res.*, A, *Phys. Sci.*, **5**, 303 (1952).

Rosette Disease of Groundnuts

Rosette disease of groundnuts annually causes great losses in many parts of Africa, and the degree of loss varies considerably. The disease is present in the three areas farmed by the Overseas Food Corporation in Tanganyika. At Kongwa in the Central Province losses are negligible, at Nachingwea in the Southern Province serious, while at Urambo in the Western Province they have been so great that groundnuts are no longer grown.

The vector of the disease is *Aphis craccivora* Koch. In natural bush the vector has been found on about twenty plant species, mostly Leguminosae, at

different times of the year. None of these has yet been proved to be a host of the virus[1]. The principal variety of groundnut grown by the Corporation, Natal Common, is a short-season type, the seed of which is able to germinate when the plant is mature. Under suitable conditions of soil moisture volunteer plants from seed left in the ground at harvest provide host plants during the dry season for the vector and also the virus. Thus both vector and virus can survive until the early rains fall and new volunteers appear which soon become infected and are a source of virus for the new crop.

The negligible incidence of the disease at Kongwa is probably due to low rainfall, which usually has ceased by harvest time, so that soil conditions are not favourable for the germination of seed left in the ground. The few that do germinate usually die before the onset of the next rains. At Nachingwea and Urambo conditions are usually favourable for the germination of seed left in the ground and large numbers of volunteers appear, a high proportion of which survive through the dry season, carrying both the virus and its vector. Attempts at eradication of volunteers during the dry season by ploughing or discing have not proved satisfactory; on some soil types the soil is so hard that the blades do not penetrate sufficiently to give a good kill. Several operations would prove too costly.

Recent work at Nachingwea has revealed several promising lines of control. The systemic insecticide 'Schradan' used as a seed dressing has given complete control of aphids for the first three weeks in the life of the plant and also reduced the initial incidence of the disease, presumably by killing incoming infective winged aphids before they could infect several plants.

In a variety trial in 1951, Mwitunde appeared to show some resistance. In a similar trial in 1952 two strains of this variety showed considerably less disease than the other twenty-three varieties and gave the highest yields. A small area planted with these two strains for selection purposes showed only a few plants infected, while an adjacent area planted with other varieties was badly infected. Mwitunde seed was planted in a recently sown field of Natal Common. The resulting plants and some Natal Common plants were infested with infective aphids nine days after emergence. Two weeks later, the percentage of Mwitunde plants free from aphids, 34 per cent, was significantly higher than that for Natal Common, 14 per cent. The spread of infective aphids was measured by the number of Natal Common plants adjacent to the test plants that showed rosette. The spread from Natal Common was nearly six times higher than that from Mwitunde, the difference being highly significant.

The mechanism of this resistance has been investigated. Tests showed that when infested experimentally with infective aphids, Mwitunde was infected to the same extent as other varieties. Thus it appeared that its resistance was due to some difference in the behaviour of the vector on it. Field studies and laboratory tests showed that *A. craccivora* had no marked preference for other varieties over Mwitunde. In a series of experiments the rate of reproduction of the aphid on Mwitunde was highly significantly less than on Natal Common, being approximately only one-third. An explanation can now be offered for the higher percentage of uninfested plants of Mwitunde as compared with Natal Common. Coccinellid and syrphid predators, which are numerous locally, were able to exterminate a higher percentage of colonies on Mwitunde because of their lower rate of increase. This resistance factor is only of value in areas where a suitably high predator population occurs, since although the rate of reproduction is comparatively low on Mwitunde, it is sufficiently rapid to cause loss of crop unless predators are present.

The more rapid extermination of colonies on Mwitunde only partly explains the lesser spread of disease on this variety. Tests of the percentages of aphids able to transmit rosette when reared on Mwitunde and Natal Common showed great variation in the degree of infectivity; but it was always lower on Mwitunde.

Percentage of infective aphids from Natal Common	Mwitunde	
31	0	$P = 0{\cdot}01$
6	0	$P = 0{\cdot}05$
51	33	$P = 0{\cdot}01$
35	15	$P = 0{\cdot}01$

The fourth experiment was designed to test differences in the infectivity of aphids from different plants as well as between varieties. There were highly significant differences between plants for both varieties, the range for Natal Common being 8–71 per cent, and for Mwitunde 0–32 per cent, suggesting that this resistance factor might be present to some degree even in such a uniform variety as Natal Common.

A third factor is being studied. In two instances where Mwitunde was so badly rosetted that ploughing in was considered, the yield proved to be 660 and 710 lb. of pods per acre compared with 1,040 lb. for a field much less severely rosetted. This suggests that the variety may have some tolerance to the virus.

Mwitunde possesses a further valuable characteristic, that of seed dormancy. The seed does not germinate until about ten weeks after the crop has reached maturity. By the time this dormant period has passed, the soil has dried considerably and only an occasional seed germinates. Thus there is an effective break in the carry-over of virus and vector from one crop to the next.

Mwitunde is a very mixed variety, showing great variation in size of plant, in habit, from prostrate to erect, and in pod and kernel characters. Thus the possibility of selecting a strain showing high yielding capacity together with a field resistance to rosette greater than that shown by the variety as at present constituted appears promising.

A. C. Evans

Overseas Food Corporation,
Nachingwea,
Tanganyika Territory.
Feb. 19.

[1] Story, H. H., Annual Report, East African Agriculture and Forestry Department, 35 (1952).

Life-history of *Porphyra*

In a recent publication[1], Kurogi reports the existence of a *Conchocelis*-phase in the life-history of four Japanese species of *Porphyra*. He confirms my observations on the germination of the spores liberated from thalli of *P. umbilicalis* v. *laciniata* as first reported in *Nature*[2] and described more fully in a recent publication[3]. Thus, the existence of a *Conchocelis*-phase in the life-history of species of *Porphyra* appears general. It also appears that the

Conchocelis-phases of various species of *Porphyra* are very similar. As might be expected, the *Conchocelis*-phase of *Bangia*[4], a description of which is being prepared for publication, shows slight differences.

Fertile cell-rows develop on the *Conchocelis*-phase in abundance and the next step in the elucidation of the life-history consists in showing how these spores are liberated and into what type of thallus they develop. Kurogi[1] shows they are liberated into the culture solution in great profusion[5], thus confirming my view and not that held by earlier investigators[6,7] who supposed they were liberated laterally from each cell into the shell. Kurogi observed and figures the very early stages in the germination of these spores in all four species, *P. tenera* Kjellm., *P. suborbiculata* Kjellm., *P. umbilicalis* (L.) J.Ag. *prox.* and *P. pseudolinearis* Ueda. The method of germination of these spores is quite different from those which give rise to the *Conchocelis*-phase and consists (excepting those of *P. umbilicalis, prox.*) of a very short row of quadrate cells. The cell contents are not indicated. Those of *P. umbilicalis prox.* show longitudinal division in the apical cell at a very early stage and they soon become obovate. None of the germlings figured has more than fifteen cells, the majority fewer. Korugi concludes that the spores liberated from the *Conchocelis*-phase "germinated into such a bud of the leafy thallus of *Porphyra* as is found in the sea and they did not penetrate again into the shells".

If, in fact, these germlings had been grown on and had developed into the leafy *Porphyra* thallus, it would appear that either the life-histories of different species of *Porphyra* may be variations of a basic type, or that the life-history of a given species may not always follow the same course. For one thing, the occurrence of 'plantlets' of considerable size and vigour, with every character of an independent phase, has been demonstrated already in the life-history of *P. umbilicalis* v. *laciniata*[3,8]. Moreover, a further experiment I have carried out has demonstrated that sterile shells introduced into a culture vessel containing shells 'infected' with the *Conchocelis*-phase of this species themselves become 'infected' with the *Conchocelis*. The first sterile shells to be introduced were in contact with the 'infected' ones; but subsequent sterile shells were suspended, by means of nylon thread, in such a way that they touched neither the vessel nor the 'infected' shells. Still they became 'infected' with *Conchocelis*. In some cases the points of 'infection' were very numerous, as in the shell figured (Fig. 1). This shell was introduced into the culture vessel on February 27, 1953, and photographed on April 20, 1953. The culture used had been started in mid-November 1952. Similar experiments with the same results have been carried out with the *Conchocelis*-phase of *Bangia fuscopurpurea* from Naples. It is clearly necessary to establish the method by which the spread of the *Conchocelis*-phase from one shell to another has taken place, whether by vegetative filaments or spores, and, if spores, whether there are two types of spores formed, as appears possible on the basis of Kurogi's observations and those now reported.

It is certain that there is still much to be learnt about the life-history of *Porphyra*.

Kathleen M. Drew
Department of Cryptogamic Botany,
University of Manchester.
June 4.

[1] Kurogi, M., Bull. Tôhoku Reg. Fish. Res. Lab. No. 2, 67 (1953).
[2] Drew, K. M., *Nature*, **164**, 748 (1949).
[3] Drew, K. M., *Ann. Bot.*, N.S., **18**, 183 (1954).
[4] Drew, K. M., *J. Linn. Soc.* (Bot.), **55**, 84 (1953).
[5] Kurogi, M., Bull. Tôhoku Reg. Fish. Res. Lab. No. 2, 104 (1953).
[6] Rosenvinge, L. K., Dansk. Vidensk. Selsk. Skrift. VII. Mat.-nat. Afd., 7 (1909–31).
[7] Jao, C. C., *Papers Mich. Acad. Sci. Arts, Letters*, **22**, 111 (1937).
[8] Drew, K. M., Proc. 7th Inter. Bot. Cong., 1950, 835 (1953).

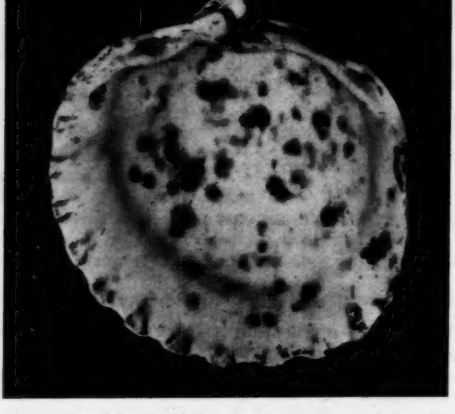


Fig. 1. Sterile shell suspended in culture vessel containing shells 'infected' with the *Conchocelis*-phase of *Porphyra umbilicalis* v. *laciniata* on February 27, 1953, and photographed April 20, 1953. Note the numerous areas of 'infection' by *Conchocelis* now clearly visible. The dark linear areas in the fluting at the edge of the shell are mostly due to diatoms. Nat. size

A Rare Fungus in Surrey

On October 24, 1953, I was fortunate in collecting an example of the rare fungus *Battarraea phalloides* (Dicks) Pers. The locality was Druid's Grove, Boxhill, and it was growing at the base of one of the large old yew trees which are a feature of that particular area. The specimen was rather small (9 cm. tall), as most records mention about one foot in height. Very few specimens have been recorded since it was first described by Thomas Woodward in 1784.

Dr. J. Ramsbottom, who deals extensively with this species in his recent book "Mushrooms and Toadstools", remarks that it is surprising that it is known with certainty elsewhere only from one locality in France and one, or perhaps two, in Italy. Incidentally, he also states that the last British record was from Temple Guiting, Gloucestershire, in 1915; but it now transpires that an example was found at the base of an elm trunk (in a hedgerow) at Callow Hill, near Virginia Water, Surrey, by Miss Notley on November 1, 1944, and is now at the Royal Holloway College.

My Boxhill specimen has been handed over to Mr. J. T. Palmer, who has kindly undertaken a revision of the British Gasteromycetes on behalf of the British Mycological Society.

W. J. Finnigan
87 Wickham Avenue,
Cheam, Surrey.
March 8.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, June 28—Friday, July 2

ROYAL INSTITUTE OF CHEMISTRY (at the University, St. Andrews)—Symposium on "Recent Advances in the Chemistry and Industrial Applications of Cellulose".

Wednesday, June 30

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 4.45 p.m.—Dr. Alfredo Mazzoni: "The Steam Vents of Tuscany". Exhibits relating to the Piltdown problem by Mr. A. T. Marston; Prof. W. E. Le Gros Clark, F.R.S., and Dr. J. S. Weiner; Mr. S. H. V. Bowie and Dr. C. E. Davidson; Dr. G. F. Claringbull and Dr. M. H. Hey; Dr. K. P. Oakley.

INSTITUTE OF METALS (at 4 Grosvenor Gardens, London, S.W.1), at 5 p.m.—Prof. E. Orowan, F.R.S.: "The Brittle Fracture of Metals: Some New Developments".

Thursday, July 1

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. H. S. Scott (McMaster University): "The Influence of Aerial Methods on the Evolution of Geological Reconnaissance".

INSTITUTE OF PHYSICS, LONDON AND HOME COUNTIES BRANCH (at the Royal Institution, Albemarle Street, London, W.1), at 6 p.m.—Dr. Karl Darrow: "Some Current Work at Bell Telephone Laboratories".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER (with veterinary qualifications) IN ANIMAL PHYSIOLOGY AND ANIMAL HEALTH in the Department of Agriculture (Animal Husbandry)—The Registrar, University College of Wales, Aberystwyth (June 30).

UNIVERSITY DEMONSTRATOR IN PHYSICAL ANTHROPOLOGY at the University of Cambridge—The Secretary of the Appointments Committee, Faculty of Archæology and Anthropology, Downing Street, Cambridge (June 30).

SCIENTISTS (with a good honours degree or equivalent, in engineering or physics, and with relevant postgraduate experience in any of the following fields: light engineering development, pneumatic and/or hydraulic mechanism design, design of light electromechanical mechanisms, optical mechanisms), at the National Coal Board Central Research Establishment II, Isleworth, Middlesex, to undertake fundamental research into the underground problems arising in the mining of coal—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/791 (July 1).

ASSISTANT LECTURER IN BACTERIOLOGY—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (July 3).

ASSISTANT LECTURER (qualified to teach the history of modern philosophy) OF PHILOSOPHY—The Registrar, University College of North Staffordshire, Keele, Staffs. (July 3).

ASSISTANT (with a recognized qualification in microbiology or training or experience in microbiological methods) IN MICROBIOLOGY at Long Ashton Research Station—The Secretary, Research Station, Long Ashton, Bristol (July 3).

EXPERIMENTAL OFFICERS or ASSISTANT EXPERIMENTAL OFFICERS (with H.S.C. (science) or equivalent; a pass degree in mathematics or experience in computing, aerodynamics, statistics, etc., an advantage), at Ministry of Supply Experimental Establishments in or near London, for computational work connected with performance of armaments and aircraft, supervision of a small group of assistants and some responsibility for the development of new computing techniques—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.154/54A (July 3).

LECTURER IN ENGINEERING—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (July 3).

RESEARCH ASSISTANT IN THE DEPARTMENT OF PURE MATHEMATICS—The Registrar, The University, Liverpool (July 3).

RESEARCH DEMONSTRATOR IN ZOOLOGY—The Registrar, The University, Sheffield (July 3).

SENIOR TECHNICIAN IN THE DEPARTMENT OF PHYSICS, University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (July 3).

LECTURER, Grade A (with a good honours degree) IN PHYSICS at Kumasi College (Gold Coast College of Technology, Science and Arts)—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (July 4).

LECTURER (with a degree or a recognized diploma in mining) IN THE DEPARTMENT OF MINING AND GEOLOGY—The Principal, Wigan and District Mining and Technical College, Wigan (July 5).

PRINCIPAL OF SOUTHALL TECHNICAL COLLEGE, Southall, Middlesex—Chief Education Officer (F/CW/2), Middlesex County Council, 10 Great George Street, London, S.W.1 (July 5).

ASSISTANT LECTURER IN GEOGRAPHY—The Registrar, The University, Sheffield (July 7).

CHAIR OF CHEMISTRY at Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (July 10).

LECTURER and an ASSISTANT LECTURER IN THE DEPARTMENT OF GEOGRAPHY—The Registrar, The University, Manchester 13 (July 10).

ASSISTANT LECTURER IN CHEMISTRY—The Registrar, Wye College, near Ashford, Kent (July 12).

SCIENTIFIC OFFICER (with a good honours degree in botany or agricultural botany, and an interest in fruit culture) IN THE DEPARTMENT OF POMOLOGY, for research into the growth and development of soft fruit plants, principally the raspberry, and an EXPERIMENTAL OFFICER IN THE VEGETABLE CULTURE SECTION, to assist with a plant breeding programme for varieties suited to Scottish conditions—The Secretary, Scottish Horticultural Research Institute, Mylnefield, Invergowrie, by Dundee (July 15).

LECTURER or RESEARCH ASSISTANT IN BACTERIOLOGY AND VIRUS DISEASES—The Registrar, The University, Sheffield (July 17).

RESEARCH FELLOW IN PURE MATHEMATICS—The Registrar, The University, Edgbaston, Birmingham (July 17).

SENIOR LECTURER (preferably qualified and willing to develop research in geochemistry) IN GEOLOGY at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, July 19).

CHAIR OF EDUCATION at the University of Adelaide, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, July 30).

PROFESSOR OF GEOPHYSICS—The Director, Institute of Astronomy, Helwan, Egypt (July 31).

PROFESSOR OF PHYSICS at Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (New Zealand, July 31).

ASSISTANT ENTOMOLOGIST (Senior Scientific or Scientific Officer grade) IN THE BEE RESEARCH DEPARTMENT, for work on bee breeding and the pollination of crops—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

CHEMIST (with a degree in natural science, and preferably with postgraduate experience, particularly in soil survey work) IN THE AGRICULTURAL DEPARTMENT, Sierra Leone, to make a soil survey of part of the Northern Province of Sierra Leone, with particular reference to the nutrient status and fertilizer requirements of soils suitable for mechanized rice cultivation—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.63/15/04.

CHEMIST (with an honours degree and preferably with some knowledge of food analysis) for research and analytical work in connexion with the study of problems of fruit and vegetable preservation—The Director, Fruit and Vegetable Canning and Quick Freezing Research Association, Research Station, Chipping Campden, Glos.

DEMONSTRATOR IN PHYSICS—The Registrar, The University, Nottingham.

ENGINEERS, SCIENTISTS and ARCHITECTS (with an aptitude for committee work), to act as Secretaries to Committees dealing with a variety of subjects—The Establishment Officer, British Standards Institution, 2 Park Street, London, W.1.

EXPERIMENTAL OFFICERS (with at least H.S.C. (science) or equivalent, and preferably with a pass degree in chemical engineering or applied chemistry), or ASSISTANT EXPERIMENTAL OFFICERS (with at least H.S.C. (science) or equivalent), to assist in chemical engineering investigations and development work—The Administrative Officer (Recruitment), Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 74/W.G.E./34.

LECTURER IN EDUCATION at the University of Tasmania—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1.

LIVESTOCK RESEARCH OFFICER (with a good honours degree in agriculture or equivalent, and at least four years postgraduate experience in field experimentation and tropical agriculture, with particular reference to pasture management and animal husbandry), at Ebini Livestock Experimental Station, British Guiana, for duties which will include the planning and supervision of research and other projects for the purpose of ascertaining the most economic methods of developing the minerally-deficient savannahs of the area—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.87/30/01.

MATHEMATICIANS, SCIENTIFIC OFFICER, ASSISTANT EXPERIMENTAL OFFICER or EXPERIMENTAL OFFICER grades, at Ministry of Supply Research and Development Establishments, mainly in Southern England, for work in problems chiefly concerned with aircraft, radio and radar equipment and armaments—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.141/54A.

RESEARCH ASSISTANTS (with a good honours degree in physics, and preferably with previous experience in solid state physics) IN THE PHYSICS DEPARTMENT—The Professor of Physics, University of Reading, Physics Research Laboratories, 78 Upper Redlands Road, Reading, Berks.

SCIENTIFIC OFFICERS, CHEMISTS and CHEMICAL ENGINEERS (with a first- or second-class honours degree in chemistry, physics or chemical engineering or equivalent qualification, and preferably with experience in one of the following: (*a*) Infra-red spectroscopy in the field of organic chemistry; (*b*) development of new methods and application of physico-chemical techniques in an analytical laboratory with an organic bias; (*c*) organic chemistry, particularly with the synthesis of fluorine derivatives or organic compounds; (*d*) development of laboratory methods of organic synthesis to pilot plant scale), at the Atomic Weapons Research Establishment, Aldermaston, Berkshire—The Administrative Officer (Recruitment), A.W.R.E., Aldermaston, Berks, quoting 112/W.G.E./2.

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (with a first- or second-class honours degree in mathematics or physics, or equivalent qualifications, and for the senior post at least three years postgraduate research experience), to work on theoretical problems with meteorological applications—The Administrative Officer (Recruitment), Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting 149/W.G.E./34.

TECHNICAL LIBRARIAN AND INFORMATION OFFICER (Chartered Librarian with considerable experience in industrial libraries, and preferably with a technical or scientific qualification), to establish and develop an information department and library in an important industrial organization in the Midlands—The Director, Aalib, 4 Palace Gate, London, W.8.

TECHNICIAN (BIOCHEMICAL) (preferably with experience in organic chemistry), for research and some routine work on steroids—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2.

TOBACCO RESEARCH OFFICER (with a good honours degree in botany, agricultural botany or agriculture, and at least two years postgraduate training and experience in field experimentation and crop husbandry generally) in the Department of Agriculture, Nyasaland, to carry out experimental work on tobacco growing and curing, under the general direction of a tobacco expert—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.63/4/04.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement

Great Britain and Ireland

Department of Scientific and Industrial Research and Fire Offices' Committee. Fire Research Bulletin No. 1: Fire and the Atomic Bomb. By D. I. Lawson. Pp. vi+30. (London: H.M. Stationery Office, 1954.) 2*s.* 6*d.* net. [304

Library Association. Year Book, 1954. Pp. lxviii+476. (London: Library Association, 1954.) 21*s.* (15*s.* to members.) [304

Department of Scientific and Industrial Research: Road Research Laboratory. Road Research Technical Paper No. 29: The Use of Stabilized Soil for Road Construction in the U.S.A. By K. E. Clarke. Pp. vi+26+16 plates. (London: H.M. Stationery Office, 1954.) 2*s.* 6*d.* net. [304

British Electrical and Allied Industries Research Association. Thirty-Third Annual Report—1st January, 1953 to 31st December, 1953. Pp. 160. (Leatherhead: British Electrical and Allied Industries Research Association, 1954.) [304

Discussions of the Faraday Society. No. 16, 1954: The Physical Chemistry of Dyeing and Tanning. Pp. 256+4 plates. (London: Faraday Society, 1954. Agents: Aberdeen University Press.) 35*s.* net. [35

Universities Council for Adult Education. Report on the year 1952–1953. Pp. 38. (Bristol: W. E. Salt, The University, 1954.) [35

University Grants Committee. Returns from Universities and University Colleges in receipt of Treasury Grant, Academic year 1952–1953. Pp. 44. (Cmd. 9130.) (London: H.M. Stationery Office, 1954.) 2*s.* 6*d.* net. [35

Contributions from the Armagh Observatory. No. 9: A Climatological and Astronomical Interpretation of the Ice Ages and of the Past Variations of Terrestrial Climate. By E. J. Öpik. Pp. 79. (Armagh: Armagh Observatory, 1953. Agents: B. H. Blackwell, Ltd., Oxford.) 10*s.* 6*d.* net. [35

School of Cosmic Physics: Dublin Institute for Advanced Studies. Geophysical Bulletin No. 8: Convective Transfer in the Problem of Climate. By E. J. Öpik. Pp. 14. (Dublin: School of Cosmic Physics: Dublin Institute for Advanced Studies, 1953.) 3*s.* 6*d.* [35

The Growth of Pension Rights and Their Impact on the National Economy—a Study prepared for the Institute of Actuaries and the Faculty of Actuaries. By F. W. Bacon, B. Benjamin and M. D. W. Elphinstone. Pp. 62. (London: Institute of Actuaries, 1954.) [35

Other Countries

Science Reports of the Tohoku University, Sendai, Japan. Second Series (Geology), Vol. 25: The Geology of Sendai and Its Environs. Edited by Shoshiro Hanzawa, Kotora Hatai, Jun-ichi Iwai, Nobu Kitamura and Toyokichi Shibata. Pp. 50+2 maps and 4 charts. (Sendai: Tohoku University, 1953.) [304

East Africa High Commission. East African Marine Fisheries Research Organization. Annual Report, 1952. Pp. 12. Annual Report, 1953. Pp. 26. (Nairobi: East Africa High Commission, 1953 and 1954.) [304

International Scientific Radio Union. Special Report No. 3: Discrete Sources of Extra-Terrestrial Radio Noise. Pp. 56. (Brussels: International Scientific Radio Union, 1954.) 75 Belgian francs; 11*s.*; 1 dollar 4 cents. [304

U.S. Department of Commerce: National Bureau of Standards. Handbook 55: Protection Against Betatron-Synchrotron Radiations up to 100 Million Electron Volts. Pp. vi+52. (Washington, D.C.: Superintendent of Documents, 1954.) 25 cents. [35

Metropolitan Life Insurance Company. Statistical Bulletin, Vol. 35, No. 3 (March 1954): Some Aspects of the Baby Boom. Pp. 12. (New York: Metropolitan Life Insurance Company, 1954.) [35

Annals of the New York Academy of Sciences. Vol. 56, Art. 7: Mathematical Deductions from Empirical Relations Between Metabolism, Surface Area, and Weight. By Herman von Schelling. Pp. 1143–1164. 1 dollar. Vol. 57, Art. 4: Branched Molecules. By F. R. Erich and 18 other Authors. Pp. 325–450. 3.50 dollars. Vol. 57, Art. 5: Parental Age and Characteristics of the Offspring. By L. C. Strong and 21 other Authors. Pp. 451–614. 3.50 dollars. Vol. 58, Art. 1: Neurotoxoid Interference with Two Human Strains of Poliomyelitis in Rhesus Monkeys. By Murray Sanders, Manuel G. Soret and Benjamin A. Akin. Pp. 12. 50 cents. Vol. 58, Art. 2: Basic Odor Research Correlation. By A. R. Behnke and 33 other Authors. Pp. 13–260. 3.50 dollars. (New York: New York Academy of Sciences, 1953 and 1954.) [35

Handlist of Malaysian Odonata: a catalogue of the Dragonflies of the Malay Peninsula, Sumatra, Java and Borneo, including the adjacent small islands. By M. A. Lieftinck. ("Treubia", Vol. 22—Supplement, February 27, 1954.) Pp. xiii+202. (Kebun Raya, Indonesia: Museum Zoologicum Bogoriense, 1954.) [35

Smithsonian Miscellaneous Collections. Vol. 122, No. 9: Insect Metamorphosis. By R. E. Snodgrass. Pp. iv+124. (Publication 4144.) Vol. 123, No. 1: Songs and Stories of the Ch'uan Miao. By David Crockett Graham. Pp. xii+336+24 plates. (Publication 4139.) (Washington, D.C.: Smithsonian Institution, 1954.) [35

Museum of Comparative Zoology at Harvard College. Breviora, No. 31 (March 3, 1954): New Freshwater Gastropod Mollusks of the African Genus *Lanistes*. By T. Pain. Pp. 4. No. 32 (March 12, 1954): Fossils and the Distribution of Chelyid Turtles. 2: Additional Reputed Cheiyid Turtles on Northern Continents: *Palaeaspis compbelli* (Owen)—a Pelomedusid. By Ernest Williams. Pp. 6. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1954.) [35

Bulletin of the Museum of Comparative Zoology at Harvard College. Vol. 111, No. 3: Random Notes on North American Carabidae (Coleopt). By Carl H. Lindroth. Pp. 117–162. Vol. 111, No. 4: Chirotherium Lulli, a Pseudosuchian Reptile from New Jersey. By Donald Baird. Pp. 163–192+2 plates. Vol. 111, No. 5: The Spider Genus Mangora (Argiopidae) in Panama. By Arthur M. Chickering. Pp. 193–216. Vol. 111, No. 6: Exotic Earthworms of the United States. By G. E. Gates. Pp. 217–258. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1954.) [35

Annual Report of the Director of the Museum of Comparative Zoology at Harvard College, 1952–1953. Pp. 24. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1953.) [35

Chronicle of the World Health Organization. Vol. 8, No. 2–3 (February–March 1954): Treponematoses—a World Problem. Pp. 37–114. (Geneva: World Health Organization; London: H.M. Stationery Office, 1954.) 3*s.* 6*d.*; 0.50 dollars; 2 Swiss francs. [35

Inter-American Tropical Tuna Commission. Annual Report for the year 1952. Pp. 62. (La Jolla, Calif.: Inter-American Tropical Tuna Commission, 1953.) [35

Chicago Natural History Museum. Fieldiana: Zoology. Vol. 34, No. 1: Social Feeding Behaviour of Birds. By Austin L. Rand. Pp. 72. (Chicago: Chicago Natural History Museum, 1954.) 1 dollar. [35

World Health Organization. Technical Report Series No. 85: Expert Committee on Alcohol—First Report. Pp. 16. (Geneva: World Health Organization; London: H.M. Stationery Office, 1954.) 1*s.* 9*d.*; 0.25 dollars; 1 Swiss franc. [35

U.S. Department of Agriculture. Leaflet No. 250: The Imported Fire Ant—How to Control It. Pp. 8. (Washington, D.C.: Government Printing Office, 1954.) 5 cents. [35

First Annual Report of the West African Institute for Oil Palm Research, 1952–1953. Pp. 136. (Benin City: West African Institute for Oil Palm Research; London: Crown Agents for Overseas Governments and Administrations.) 2*s.* 6*d.* [35

Union Internationale de Chimie Pure et Appliquée. Comptes Rendus de la Dix-Septième Conférence, Stockholm 29 Juillet—4 Août 1953. Pp. 172. (Paris: Union Internationale de Chimie Pure et Appliquée, 1954.) [35

Report on International Definition and Measurement of Standards and Levels of Living. (Report of a Committee of Experts convened by the Secretary-General of the United Nations, jointly with the International Labour Office and UNESCO.) Pp. xii+96. (New York: United Nations; London: H.M. Stationery Office, 1954.) 0.80 dollars; 6*s.*; 3 Swiss francs.

Histochemische Methoden. Eine Sammlung herausgegeben von Walther Lipp. Lieferung 1. Pp. iv+24. (Munchen: R. Oldenbourg, 1954.) [35

Bulletin of the American Museum of Natural History. Vol. 103, Art. 4: Birds of Central New Guinea—Results of the American Museum of Natural History Expeditions to New Guinea in 1950 and 1952. By Ernst Mayr and E. Thomas Gillard. Pp. 311–374+plates 13–34. (New York: American Museum of Natural History, 1954.) 2 dollars. [35

Proceedings of the American Academy of Arts and Sciences. Vol. 83, No. 1: Certain Effects of Pressure on Seven Rare Earth Metals. By P. W. Bridgman. Pp. 22. 60 cents. Vol. 80, No. 4: Psychoanalysis and the Unity of Science. By Else Frenkel-Brunswik. (Contributions to the Analysis and Synthesis of Knowledge—4. Published in co-operation with the Institute for the Unity of Science.) Pp. 271–350. 1.55 dollars. (Boston, Mass.: American Academy of Arts and Sciences, 1954.) [35

Conspectus of the Research Institute for Iron, Steel and other Metals, Tohoku University. Pp. 16. Compendium of the Achievements of the Research Institute for Iron, Steel and other Metals, Tohoku University. Pp. iv+72. (Sendai: Tohoku University, 1951 and 1952.) [105

American Philosophical Society. Year Book 1953, January 1, 1953–December 31, 1953. Pp. 517. (Philadelphia: American Philosophical Society, 1954.) [105

On the Congruence of Sets and Their Equivalence by Finite Decomposition. By Prof. Waclaw Sierpinski. (Lucknow University Studies No. 20. Faculty of Science, Session 1948–49.) Pp. v+117. (Lucknow: Lucknow University, 1954.) [105

Foreign Trade Zones in the U.S.A.: Report of a Group of European Experts. (Technical Assistance Mission No. 28.) Pp. 68. (Paris: Organization for European Economic Co-operation; London: H.M. Stationery Office, 1954.) 240 French francs; 4*s.* 6*d.* net; 0.75 dollars. [105

Indians of the Western Frontier—Paintings of George Catlin. By George I. Quimby. Pp. 78 (35 plates). (Chicago: Chicago Natural History Museum, 1954.) 50 cents. [105

At Work for Europe: An Account of the Activities of the Organisation for European Economic Co-operation. Pp. 88. (Paris: Organisation for European Economic Co-operation; London: H.M. Stationery Office, 1954.) [105

Clinica Medica dell' Universita di Firenze. Lipoproteine ed Eparina nel Quadro Umorale della Chemiopatogenesi dell' Ateroscleresi. Da F. M. Antonini, G. Piva, L. Salvini, A. Sordi. (Supplemento N. 1 al Giornale di Gerontologia.) Pp. 96. (Firenze: Casa Editrice Dott. Luigi Macri, 1953.) [105

Smithsonian Miscellaneous Collections. Vol. 122, No. 11: A Revision of the Sea-Stars of the Genus Tethyaster. By Ailsa M. Clark and Austin H. Clark. Pp. ii+27+12 plates. (Publication 4147.) (Washington, D.C.: Smithsonian Institution, 1954.) [105

Annual Report of the Indian Central Jute Committee for the year 1952–1953. Pp. ii+312. (Calcutta: Indian Central Jute Committee, 1954.) [105

United States Department of Agriculture. Farmers' Bulletin No. 1861: Insect Pests of the Peach in the Eastern States. Pp. 32. (Washington, D.C.: Government Printing Office, 1954.) 15 cents. [105